METI
Ministry of Economy, Trade and Industry

Green Steel for GX

Consolidated Summary of the Study Group on
Green Steel for Green Transformation
GX 推進のためのグリーン鉄研究会
とりまとめ（英語版）

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Introduction

The steel industry is considered one of the hard-to-abate sectors to decarbonize due to inevitable generation of carbon dioxide (CO_2) during iron ore reduction process with current technology. However, Japan's goal of achieving a decarbonized society cannot be realized without mitigating greenhouse gas (GHG) [1] emissions from the steel industry. To address this challenge, the steel industry is embarking on an ambitious effort to significantly mitigate its GHG emissions through its Green Transformation (GX)[2], enabling the country to achieve a carbon-neutral society by 2050.

Promotion of GX is considered to require significant capital investment, along with higher cost for raw materials and energy. Therefore, it is unlikely that GX will be advanced in the steel industry based solely on economic rationality, at least in the short term. The progress of GX will depend on various forms of social support.

Currently, the sale of "green steel" in various forms is beginning to expand both domestically and internationally. The purchase of this green steel by customers could help promote GX in the steel industry and mitigate GHG emissions. However, there is currently no clear definition of green steel, and its concept varies significantly.

This study group was established within the Ministry of Economy, Trade and Industry (METI) and held five meetings starting in October 2024. It included participation from experts in climate change, Life Cycle Assessment (LCA), energy, finance, and consumer affairs, as well as observers from companies in the steel industry and steel-using industries.

The study group discussed how to connect the expansion of the green steel market to the promotion of GX. We deliberated on issues related to market expansion and effective dissemination of information to consumers. During the discussions, the study group invited organizations and individuals interested in green steel to submit their opinions.

This report summarizes the discussions held during the five meetings of the study group.

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[1] The greenhouse gas with the highest emissions in Japan is CO_2.

[2] GX is meant to be the transformation of the industrial structure through decarbonization efforts, which will also lead to economic growth.

Chapter 1: The Situation Concerning Green Steel Sales

Currently, various brands of green steel are being sold by domestic and foreign steel manufacturers. These green steels claim to incorporate consideration for climate change in the manufacturing process of the products. The claims can be broadly classified into three categories: (1) steel products that allocate GHG emission mitigations through innovations in the manufacturing process, (2) steel products that reflect the mitigated GHG emissions from manufacturing processes that employ decarbonization technologies, and (3) steel products that lower GHG emissions associated with electricity used in electric furnaces through the use of electricity certificates, etc.

To understand the content of these green steel claims, it is essential to have a basic understanding of (a) the manufacturing process of steel products, (b) the calculation method for GHG emissions in the manufacturing process, and (c) the strategies used to reduce GHG emissions. We will briefly cover these topics in the next sections of this chapter, prior to the discussion in Chapter 2 and beyond.

Table 1 Green iron sold by domestic and international companies

Types of Green Steel	Company	Brand	Details
①Products with lower emissions due to the allocation of emission reductions generated by manufacturing process improvements, etc.	Nippon Steel	NSCarbolex™	Allocation of CO2 emissions reduced by reforming and improving manufacturing processes to any product
	JFE Steel	JGreeX	Allocation of GHG emission reductions generated by GHG emission reduction technologies to any product
	KOBE STEEL	Kobenable Steel	Allocation of CO2 reductions generated by, for example, reducing coke consumption by replacing a portion of iron ore with reduced iron, to any product as environmental value.
	thyssenkrupp	bluemint®	Allocation of CO2 reductions generated by reducing coke consumption by replacing a portion of iron ore with reduced iron, to any product as environmental value.
	ArcelorMittal	XCarb® Green steel certificate	CO2 emission reductions generated through the use of bio-coal, the blowing of coke gas into blast furnaces, and the increased use of scrap in converter furnaces are allocated to flat steel products as green steel certificates.
	Voestalpine	greentec steel	The amount of CO2 emission reduction generated by adjusting the manufacturing process, such as replacing part of the coke with a reductant containing hydrogen, is reflected in carbon footprint.
	TATA STEEL	Zeremis Carbon Lite	Allocation of CO2 emission reductions generated throughout the company to any product
	POSCO	Greenate certified steel™	Allocation of CO2 emission reduction generated by measures such as the adoption of low-carbon processes and technologies to any product
② Products manufactured with decarbonization technologies and labeled with the emissions of the manufacturing process	SSAB	SSAB Fossil-free™ steel	Products manufactured by hydrogen reduction ironmaking and labeled with the emissions of the manufacturing process
	POSCO	Greenate carbon reduced steel™	Products manufactured from newly installed electric furnaces and labeled with the emissions of the manufacturing process
③ Products that lower the emissions of electricity used in electric furnaces by means of certificates, etc.	TOKYO STEEL	ほぼゼロ	Reduction of CO2 emissions from electricity used in the manufacture of electric furnace products through the use of RE100 certificates, DR (Demand Response), etc.

Source: Prepared by the secretariat from each company's website

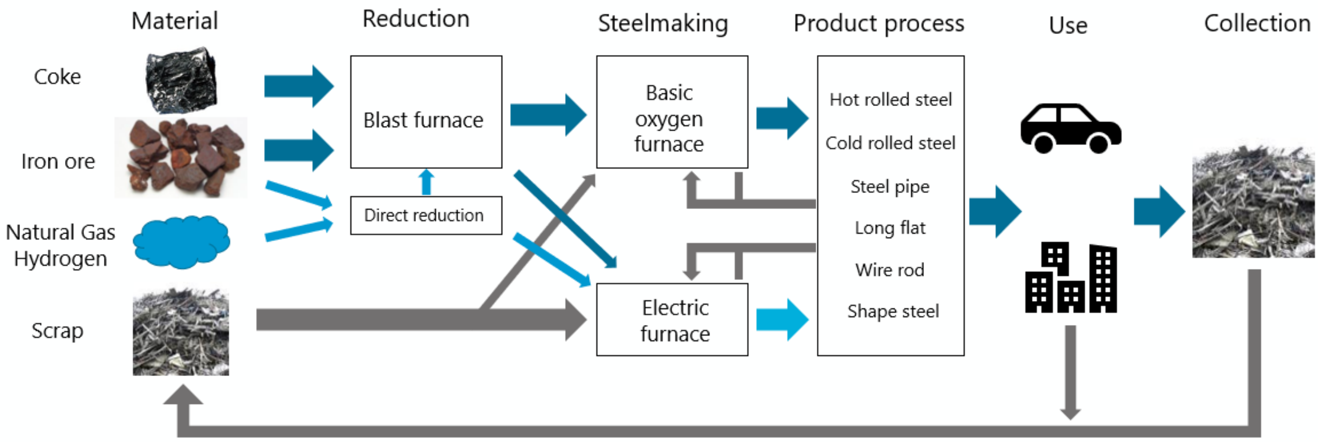
Steel Manufacturing Process

Iron (Fe) is a relatively abundant metal on Earth and exists in nature in the form of iron ore. Iron ore is a compound of iron and oxygen elements (i.e., iron oxide), and iron can be obtained by removing the oxygen element through a reduction reaction. (Method of reducing iron ore)

In addition to obtaining iron by reducing iron ore in nature, iron can also be obtained by collecting and melting down the iron produced in the past (i.e., the iron that was previously reduced from iron ore). (Methods of collecting and melting iron scrap)

Thus, there are two main methods of iron production: reducing iron ore and collecting and melting iron scrap. The primary method for reducing iron ore is the blast furnace process, where iron ore is reduced in a blast furnace. Another method for reducing iron ore is the direct reduction process, in which iron ore is reduced in a direct reduction furnace to obtain direct reduced iron (DRI)[3] , which is then melted in an electric furnace. The primary method for collecting and melting scrap iron is the electric furnace process.

Figure 1 steel manufacturing process



Source: Prepared by the secretariat of the study group referring 1) Document 4-1, "Characteristics of the Iron and Steel Industry and Actual Energy Use" submitted at FY2022 Second Meeting of the Working Group on Criteria for Factories, etc., Energy Conservation Subcommittee, Energy Conservation and New Energy Committee of the Advisory Committee for Natural Resources and Energy, 2) "Research Project for Sustainable Development of Japanese Metal Industry Based on Carbon Neutrality" (FY2021 Industrial Economics Research Commission Project)

Method for Calculating Greenhouse Gas Emissions from Manufacturing Processes

Calculating GHG emissions associated with raw materials and energy use in a company or factory is relatively straightforward. This can be done by assessing the raw materials, fuel, electricity, and other resources used in the company or factory. If we can obtain the number of products produced in addition to the calculated GHG emissions, it becomes possible to estimate GHG emissions per unit of

[3] DRI that has been briquetted to reduce the risk of ignition during marine transportation is referred as “hot briquetted iron (HBI)”.

product. However, to accurately estimate the GHG emissions of the manufacturing process, we need to consider the following points.

1) How should we set the scope of GHG emissions to be calculated?

We need to consider how to establish "organizational boundaries." These organizational boundaries can be set at the company level or the factory level. Additionally, should we measure only combustible raw materials, such as oil and coal, consumed in the factory, or should we also consider the GHG emissions associated with the electricity used in the factory, as if they were emitted during electricity generation? Furthermore, should we take into account the GHG emissions related to the extraction of minerals and intermediate materials, such as iron ore mining?

2) How should we allocate emissions per product?

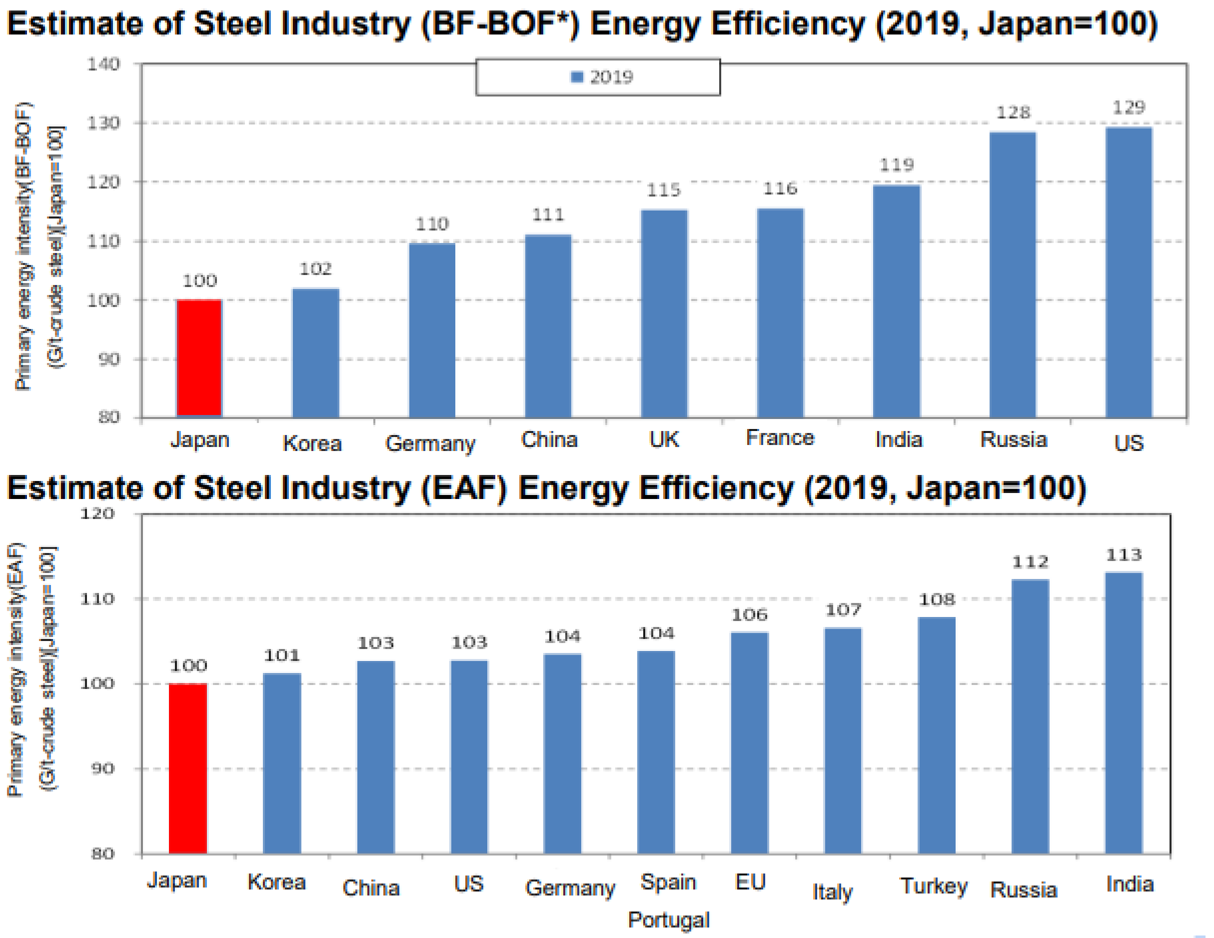
How should we allocate emissions per product when multiple products are produced from the same manufacturing process? Should we use the same approach for products of different economic values, such as a primary product and a secondary product, that are produced from the same process?

Since various issues can arise when calculating emissions from manufacturing processes, calculation rules have been established to ensure the transparency of the results. (For details, see "CFP and Green Steel for GX" (Chapter 4).

Strategies to mitigate greenhouse gas emissions in the steel industry

In the steel industry, various energy-efficiency initiatives have been implemented, including improvements in waste heat recovery, advancements in combustion technologies in blast furnaces, enhancements to power generation facilities, and the use of waste plastics collected from households and other sources. In addition, to achieve the "Carbon Neutral Action Plan," the industry has been working to enhance energy-efficiency by sharing best practices among companies. As a result, Japanese companies have achieved the highest efficiency in steelmaking in the world for both blast furnace and electric furnace methods.

Figure 2 International comparison on energy intensity during steelmaking



Source: Japan Iron and Steel Federation, "Status of Efforts on Climate Change Countermeasure: Carbon Neutral Action Plan (Low Carbon Society Action Plan) Report" (March 2022)

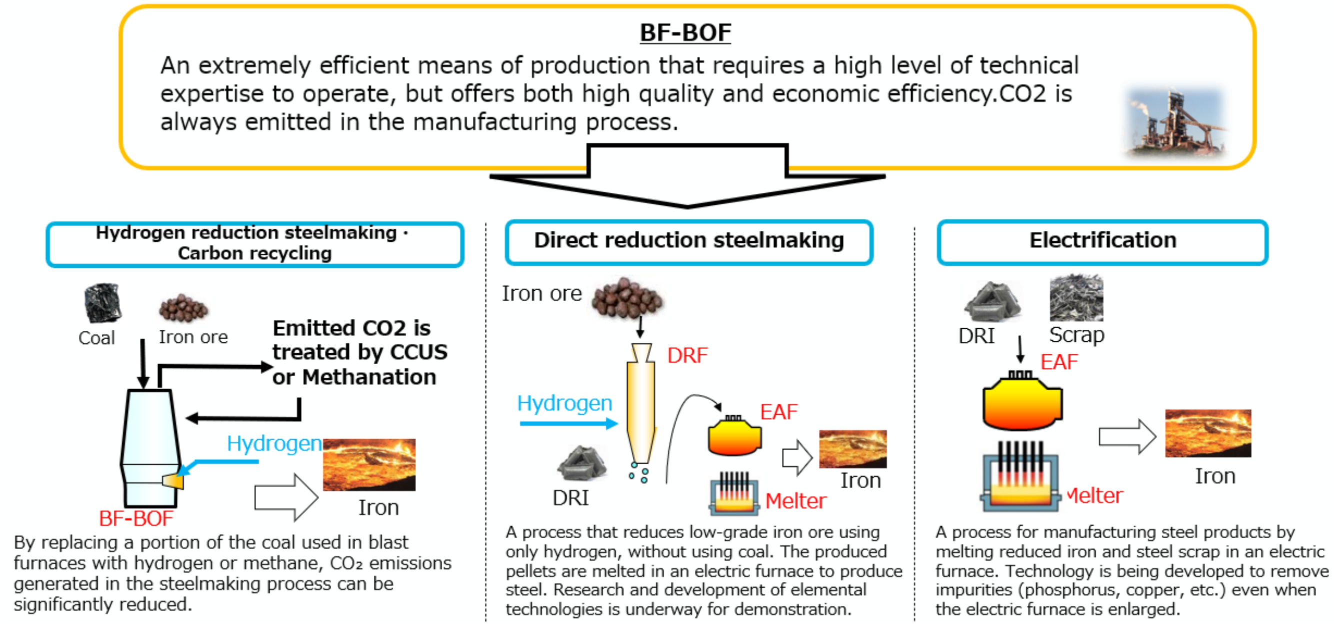
In the steel industry, the basic strategy formulated in February 2021 sets a target of mitigating energy-derived CO_2 emissions by 30% in FY2030 compared to FY 2013 level. This will be achieved by enhancing energy efficiency, utilizing waste plastics, introducing innovative technologies currently under development with a view to implementation around 2030, and using other raw fuels that contribute to CO_2 reduction.[4] In addition, in support of Japan's ambition to achieve a carbon neutral society by 2050, and in order to contribute to this goal, the Japanese steel industry announced that they will boldly pursue this goal through two approaches: 1) contributing to the society's goal with

[4] Assuming that the macro assumptions of the government's Basic Energy Plan and the necessary conditions for the implementation of various measures are in place.

its advanced technologies and products, and 2) working to reduce CO_2 emissions in its own production processes. Each company in the steel industry has formulated its own roadmap and strategy.

Currently, the majority of GHG emissions in Japan's steel industry occur in the blast furnace process, where iron ore is reduced to pig iron. The Japanese government is supporting the development of multiple technologies aimed at mitigating GHG emissions.

Figure 3 Technologies under development to mitigate GHGs emissions generated during iron ore reduction



Source: Compiled by METI

Regarding technological development, Japanese steel industry is working on developing several technologies: 1) reducing the amount of coke (coal) used in the blast furnace process by utilizing hydrogen (blast furnace hydrogen reduction technology), 2) using a direct reduction furnace to process low-grade iron ore (direct hydrogen reduction technology), and 3) melting reduced iron and other materials in an electric furnace or electric melting furnace (melter) to produce high-grade steel (Electrification using advanced electric furnace). Some of these technological developments are supported by the government through Green Innovation Fund.

In addition, the government is supporting capital investment in projects that construct innovative large electric furnaces, which will use reduced iron by direct reduction and high-purity steel scrap to produce steel with properties similar to those produced by the current blast furnace process, but with lower GHG emissions during manufacturing process.[5] Among these projects to build an innovative large electric furnaces, the first project in Japan is expected to begin commercial operation in the late 2020s.

There are also efforts to mitigate GHGs emissions by combining existing peripheral technologies and the technologies developed by individual steel companies. These technologies include the use of reduced iron in blast furnaces, biomass injection, CO_2 separation and recovery, the expansion of scrap utilization through preheating and melting, and biomass co-firing and dedicated firing in in-house boilers.

Column 1: Decarbonizing the Electricity Sector and Non-Fossil Certificates

The steelmaking industry consumes a significant amount of electricity, especially in the electric furnace process. Electricity is supplied to the steelworks through the electric power grid. In the blast furnace process, electricity is also used in the downstream processes such as rolling. When byproduct gas from the blast furnace is available, it can be utilized to generate electricity within the steel mill, which is effective use of energy.

The power grid is a network of numerous power plants and countless demand points, and it is impossible to physically trace which power plant transmits electricity to which demand point. However, from the perspective of socio-economic activities, electric utility company and electricity consumers enter into power supply contracts based on the electricity market system, allowing for the identification of relationships between power producers and electricity consumers. When calculating CO_2 emissions from electricity received from external sources, data on GHGs emissions per kWh of electricity (emission coefficients) are provided by the retail electricity providers with whom the consumers have contracts.

Under the Energy Efficiency Law, factories and business establishments that consume more than a certain amount of energy are required to report their energy consumption to the government on a

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[5] Energy and Manufacturing Process Conversion Support Program for industries in hard-to-abate sector. An innovative large scale innovative electric furnace, with a capacity of 2 million tons per year, is scheduled to be installed and begin commercial production in FY2028 at the Kurashiki district of JFE Steel's Western Japan Steel Works.

regular basis. In this context, energy usage includes not only the energy directly consumed in the factory, such as oil and natural gas, but also the electricity received from the power grid, which is also counted as the factory's energy consumption. Additionally, the Law on Countermeasures to Global Warming mandates that factories calculate their GHGs emissions and report them to the government using the Calculation, Reporting, and Publication (CRP) system for GHGs emissions. Under the scheme of this law, companies must calculate and to report the GHGs emissions associated with their use of electricity from the power grid, utilizing emission coefficients provided by the retail electricity suppliers with whom they have contracts.

By purchasing "Non-Fossil Certificates (NFC)" traded at the Japan Electric Power Exchange (JEPX), retail electric utilities can: 1)use NFCs to meet their obligation to procure electricity derived from non-fossil power sources (such as renewable energy, nuclear power) as required by the Law on the Advancement of the Energy Supply Structures, 2) subtract a certain amount of CO_2 emissions when calculating the emission factors of the electricity they sell, and 3) claim the environmental added value of the electricity they provide.

In addition, the GHG Protocol (Scope 2 Guidance) states that "Energy Attribution Certificates" can be used when calculating GHG emissions. RE100, an international initiative where companies aim to cover 100% of the electricity used by their operations with renewable energy, has announced that NFCs tagged with renewable power source using a tracking system can be used for RE100 activities. Similarly, CDP, a British non-governmental organization that operates a disclosure system for corporate GHG emissions, also permits the use of NFCs tagged with renewable power source when calculating corporate Scope 2 GHG emissions.

NFCs issued from renewable energy power plants supported by the feed-in tariff (FIT) scheme are initially attributed to the government and then sold by JEPX to retail electric utilities and others (FIT-NFCs). Purchase bid prices have the upper and lower limits, with most FIT-NFCs currently sold at 0.4 yen/kWh, the lower limit. This price can be converted to approximately 913 yen per CO_2 equivalent ton based on a specific conversion method. The traded price of FIT-NFCs is extremely low when considering the procurement cost under the FIT scheme. According to FY2024 estimates, the procurement cost is projected to be 4.8 trillion yen, while the avoided cost is estimated at 2.1 trillion yen; resulting in an additional cost of 2.7 trillion yen for the renewable electricity procurement under the FIT system. The prices of FIT-NFCs are even lower than the feed-in tariff levy, which is set at 3.49 yen/kWh in FY2024, and is also considerably lower than the GX investment required for decarbonization in the steel industry when converted to a carbon price.

It is important to note that while the use of electricity combined with NFCs will contribute to the decarbonization of the electricity sector, it will not directly mitigate GHGs emissions from the steel industry. Although the revenue from FIT-NFCs sold to retail electricity providers will help lower the FIT levy, most of the procurement costs under the FIT scheme will ultimately be borne by electricity users as a whole in the form of the FIT levy. In simple terms, FIT-NFCs do not fully reflect the true cost of renewable electricity.

On the other hand, some companies are using electricity with lower emission coefficients achieved through the procurement of NFCs in the electric furnace process. By purchasing electricity combined with FIT-NFCs, these companies contribute to the promotion of renewable energy development by partially alleviating the FIT levy burden on other electricity users, thereby supporting the decarbonization of the electricity sector. The government is also promoting this policy by allowing it to be reflected in calculations under the Energy Efficiency Law and the Law on Countermeasures to Global Warming. By using steel products that utilize such electricity, customers can indirectly participate in these efforts.

There is an opinion that electric furnace steel products utilizing NFCs should be classified as “Green Steel for GX” (see Chapter 3), and be included in the scope of support measures for demand expansion through targeted government initiatives, such as priority procurement under the Green Procurement Law. The expansion of non-fossil energy should be discussed from the perspective of energy policy. Since this study group has primarily focused on the mitigation of GHGs emissions directly emitted from the steel industry through GX investment, we will limit our discussion to acknowledging that such opinions exist.

On the other hand, for steel products utilizing NFCs, several operational methods can be considered for allocating NFCs to these products [6] [7] . While the current national carbon footprint (CFP) guideline outlines how to calculate emissions when using various types of renewable energy certificates, it is anticipated that this issue will be widely and actively discussed within the steel industry to ensure transparency in operations.

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[6] At the 2nd Study Group meeting, JFE Steel Corporation and Daido Steel Ltd. explained the status of their studies on specific operational methods for the utilization of NFCs.

[7] With discussions underway for the development of ISO/AWI 14077 (Requirements and guidelines for application of Chain of Custody (CoC) approaches in Life Cycle Assessment (LCA)) and discussions on the revision of ISO 14067:2018 (CFP), discussions may be elaborated in the future on how to allocate the electricity with NFCs and other renewable certificate to the products.

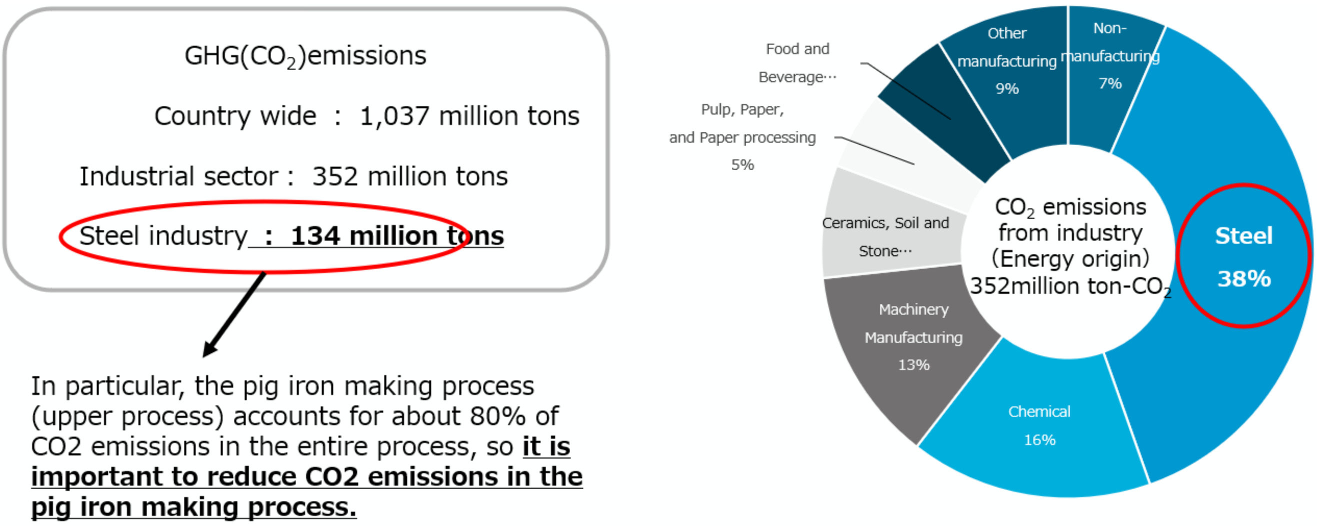
Chapter 2: Promoting GX in the Steel Industry

As mentioned in the introduction, the steel industry is considered as one of the hard-to abate sectors. However, Japan's goal of achieving a decarbonized society cannot be realized without mitigating GHGs emissions from the steel industry. The GX initiative in the steel industry is set to launch an ambitious effort to drastically mitigate GHG emissions in order to achieve a carbon-neutral society by 2050.

As mentioned in Chapter 1, the steel industry supports Japan’s ambition of achieving carbon-neutral society by 2050. To contribute to this goal, the Japanese steel industry announced that they will boldly pursue carbon neutrality, and has formulated a basic policy that includes: 1) contributing to the societal goals through advanced technologies and products, and 2) working to mitigate CO_2 emissions from its own production processes. In addition, each company in the steel industry has formulated its own roadmap and strategy to address CO_2 emissions mitigation.

In 2022, CO_2 emissions from the steel industry in Japan were approximately 138 million tons, accounting for approximately 38% of the total CO_2 emissions from the industrial sector and 13% of Japan's overall CO_2 emissions.

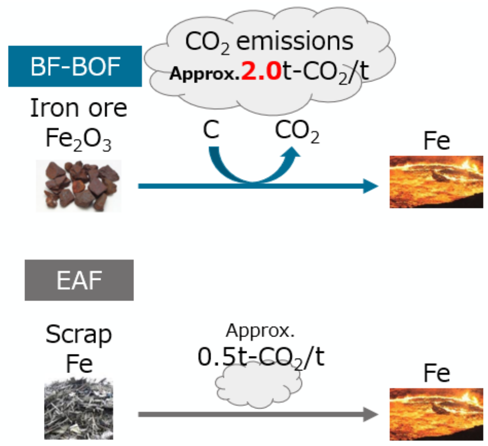
Figure 4 GHG emissions from the steel industry



Source: National Institute for Environmental Studies, “Japan’s Greenhouse Gas Emissions Data” (FY 2022 Confirmed Figure)

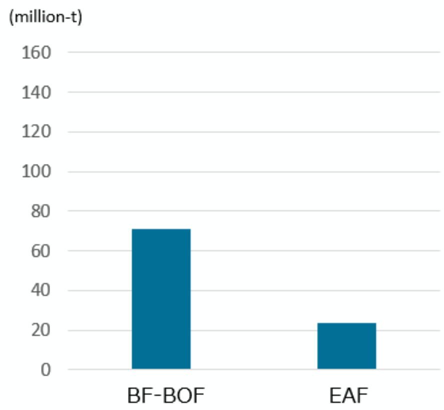
It is estimated that approximately 2 tons of CO_2 are emitted for every 1 ton of steel produced by the blast furnace process. In contrast, about 0.5 tons of CO_2 are emitted for each ton of steel is produced via the electric furnace process. Notably, more than 90% of the GHG emissions from the steel industry in Japan originate from the blast furnace process.

Figure 5 CO_2 generation by steel manufacturing processes[8]



SOURCE: JFE GROUP ENVIRONMENTAL MANAGEMENT VISION 2050 BRIEFING MATERIAL (MAY 25, 2021)

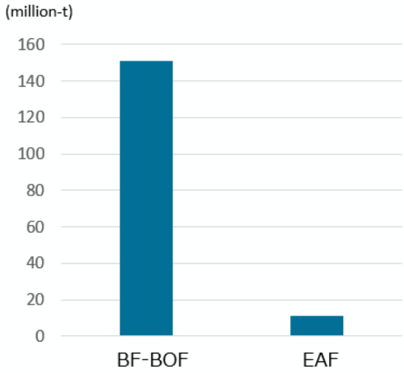
Figure 6 Crude Steel Production in Japan (2021)



SOURCE: JAPAN IRON AND STEEL FEDERATION PRODUCTION STATISTICS/TIME SERIES

[8] It is important to note that iron scrap once emits CO_2 when it is produced from iron ore by the blast furnace process (blast furnace method). When the recycling effect is considered in the LCA, the two iron-making methods do not result in a significant difference in CO_2 emissions

Figure 7 Calculated GHG Emissions (2021)



SOURCE: MINISTRY OF THE ENVIRONMENT, "GREENHOUSE GAS EMISSIONS CALCULATION, REPORTING, AND PUBLICATION SYSTEM: CFC CALCULATED LEAKAGE REPORTING AND PUBLICATION SYSTEM WEBSITE.

GHG emissions in the electric furnace process, which uses collected steel scrap for steel production, are lower than those in the blast furnace process, which involves reducing iron ore to produce steel. However, the current electric furnace process relies on steel scrap as its raw material, and the production volume of this method is limited by the availability of steel scrap.

The annual supply of steel scrap in Japan is approximately 44 million tons, of which 6.85 million tons are exported overseas. Even without these exports, the available scrap would still only meet about half of Japan's crude steel production, which is around 87 million tons[9] . It is important to note that the electric furnace process alone cannot satisfy Japan's steel demand.

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[9] Figures for 2023. Crude steel is the mass of steel before it is rolled and processed into steel products. Crude steel production consists of 64.16 million tons from the blast furnace (converter) process and 22.83 million tons from the electric furnace process. It is important to note that approximately 12 million tons of the steel scrap generated in Japan is self-generated steel scrap within steel mills, and 7.48 million tons of this self-generated steel scrap is reused in the blast furnace process during crude steel production.

Figure 8 Steel Scrap Supply in Japan (2023)

Supply total approx.44MT

Unit:1,000 t

Supply	Scrap generated in own factory 12,165			Scrap purchased domestically 25,454 (78.8%)		Export 6,851 (21.1%)	
	Converter plant 7,480	EAF plant 2,526	Casting plant 2,160	Processed scrap 7,142 (28.9%)	Wasted scrap 17,807 (71.1%)	Wasted scrap 5,481	Etc. 1,370

Scrap source →	Auto-mobile	Machine	Con-tainer	Building	Civil eng.	Etc.
	(9.6%)	(31.4%)	(2.9%)	(23.8%)	(20.3%)	(12.0%)

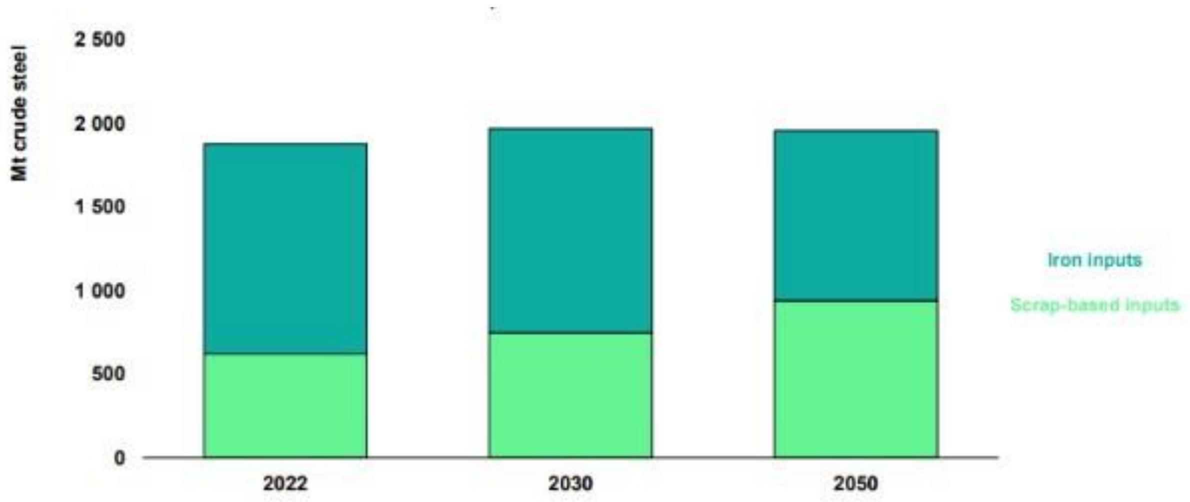
Source: Data submitted at the 3rd meeting of the Study Group by Japan Iron and Steel Recycling Industry Association. Annual Report of Iron Sources, Japan Iron Sources Association - Estimates based on surveys by the.
Japan Iron and Steel Recycling Industry Association compiled the data from the estimates by Ministry of Economy, Trade and Industry, Japan Iron and Steel Federation, Ministry of Finance, Japan Iron Sources Association, and others

One reason why steel demand cannot be met solely by the electric furnace process is that Japan has a well-developed manufacturing sector, including automobile industry, which exports finished cars and automobile parts overseas. On the other hand, on a global scale, while the accumulated amount of steel in a mature society may remain relatively stable, developing countries experiencing economic growth are seeing an increase in their steel accumulation. Consequently, the steel scrap generated from past production alone cannot satisfy global steel demand. To meet this demand that cannot be fulfilled solely by the electric furnace process using steel scrap as raw material, iron ore must be reduced to produce new steel.

According to an analysis by the International Energy Agency (IEA), even in the NetZero 2050 scenario, steel produced from steel scrap accounts for only half of the total steel supply. The remaining steel demand is expected to be met by reduced iron ore, which can be processed using hydrogen, or through a combination of fossil fuels and carbon capture, utilization, and storage (CCUS)[10] in the reduction process.

[10] CCUS: Carbon Capture, Utilization, and Storage (CCUS): Capture and underground storage of CO2 generated from the blast furnace process, etc. is envisioned.

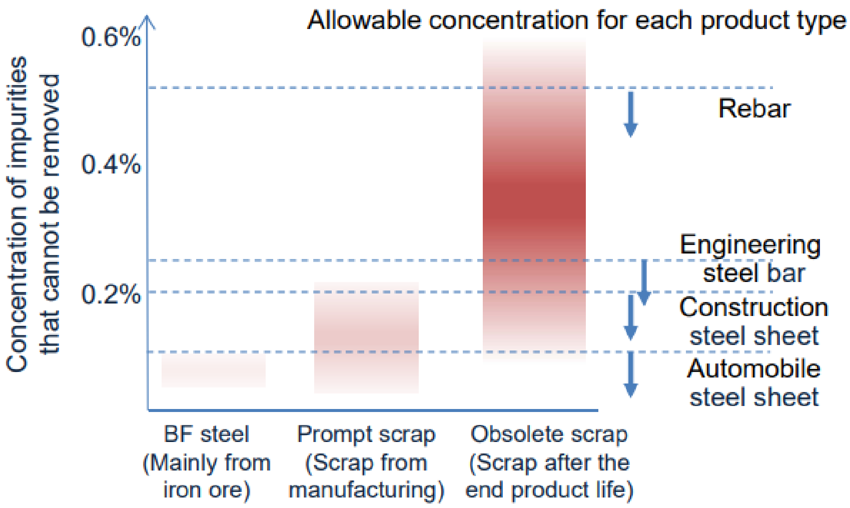
Figure 9 International Energy Agency (IEA) projections of global iron inputs (Net Zero 2050 scenario)



Source International Energy Agency (IEA)

In addition to supply and demand factors, the presence of impurities in steel scrap limit the quality of steel produced through the electric furnace process, making it unsuitable for high-grade applications, such as automobile exterior panels.

Figure 10 Impurity concentrations for each material and allowable concentrations for each variety



Source: Jones, A.J.T., Assessment of the Impact of Rising Levels of Residuals in Scrap, Proceedings of the Iron & Steel Technology Conference (2019)

Table 2 Steelmaking Applications by Type and Blast Furnace/Electric Furnace Ratio

Category	Main use	BF-BOF	EAF
H Steel	Construction・Bridge・Ship	28.2%	71.8%
Wire rod	Iron wire・Wire・Nail	49.3%	50.7%
Thick steel plate	Construction・Bridge・Shipbuilding	85.3%	14.7%
Steel sheet pile	Civil engineering	86.8%	13.2%
Hot-Dip galvanized steel	Construction・Automobile・Home appliance	87.1%	12.9%
Cold-Rolled steel	Automobile・Electrical appliance・Steel furniture	92.3%	7.7%
Hot-Rolled steel	Construction・Automobile・Industrial machinery	92.7%	7.3%

Source: The Iron and Steel Daily, Japan Iron and Steel Federation HP, etc.

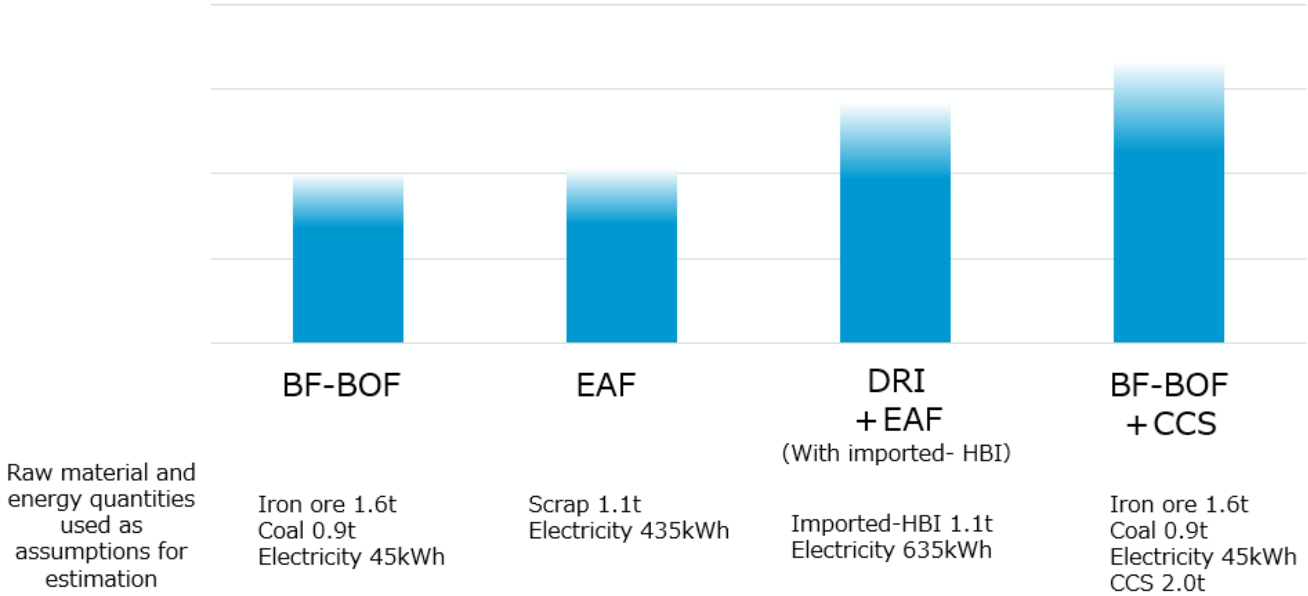
For these reasons, to mitigate GHG emissions from the steel industry and achieve a decarbonized society, it is essential to significantly mitigate GHG emissions during the reduction of iron ore while maximizing the use of iron produced through the electric furnace process that utilizes steel scrap.

Using the Green Innovation Fund, the Japanese government is currently supporting the development of technologies for both (1) hydrogen reduction in blast furnace (blast furnace hydrogen reduction technology) and (2) the reduction of low-grade iron ore with hydrogen (direct hydrogen reduction technology). The utilization of hydrogen in the reduction process is still in the technology development stage, and implementers will be encouraged to continue their efforts toward social implementation after the 2030s, when support from the Green Innovation Fund is expected to conclude.

A project is underway to melt imported DRI and high-purity steel scrap in innovative large electric furnaces, enabling the production of a wide range of steel products similar to those produced by blast furnaces. This initiative aims to significantly mitigate GHG emissions by combining existing technologies. The Japanese government is providing support for capital investment costs, covering up to one-third of eligible project expenses, through the Energy and Manufacturing Process Conversion Support Program for industries in hard-to-abate sector.

Despite government support for technological development and capital investment, the cost of iron produced through such GX investment is expected to increase significantly compared to conventional iron production, at least in the initial stages. In particular, the project to import DRI, which is anticipated to begin operation around 2030, and to melt it together with steel scrap in an innovative large electric furnace, is expected to raise raw material and energy costs by several tens of percent compared to conventional blast furnace and electric furnace processes.

Figure 11 Estimated raw material and energy costs for the production of 1 ton of iron



Sources: Referenced raw material and energy prices from Ministry of Finance Trade Statistics, Electricity Trade Bulletin, CCS Long-Term Roadmap Study Group materials, Japan Iron and Steel Recycling Industry Association HP, etc. Referenced Japan Iron and Steel Federation HP, MFG ROBOTS HP, Worldsteel HP, etc. in setting raw material and energy volumes.

In this situation, to encourage steelmakers to invest in GX, it is essential to reduce uncertainty in the business environment as much as possible, including improving the predictability of future investment returns.

Chapter 3: Direction of Support Measures Related to Green Iron for GX Promotion

As described in previous chapters, the steel production process can be broadly categorized into two processes: one involves producing steel by reducing iron ore (typically through the blast furnace process), while the other involves melting steel scrap (the electric furnace process). The production of steel products derived from steel scrap has its own limitations, such as finite supply of steel scrap. Additionally, impurities in the steel scrap can make it difficult to produce high-grade steel products, such as those used for automobile exterior panels. Therefore, the basic policy direction toward achieving a decarbonized society is to mitigate GHG emissions from the blast furnace process through GX investment, while maximizing the use of steel scrap to produce a diverse range of steel products.

On the other hand, the steel industry, particularly steel companies currently using blast furnaces, will need to make significant investments in GX. Additionally, the cost of raw materials and energy during production is expected to be higher than that of current blast furnace process.

In addition, decarbonization efforts through GX investments will not occur in a single step. As of the end of 2024, Japan has 20 blast furnaces. To promote decarbonization while ensuring a stable supply to meet demand from the automobile and other industries, each blast furnace will need to be retrofitted to accommodate hydrogen reduction ironmaking and CCUS, or converted to innovative large electric furnaces that utilize reduced iron, all according to a well-planned strategy.

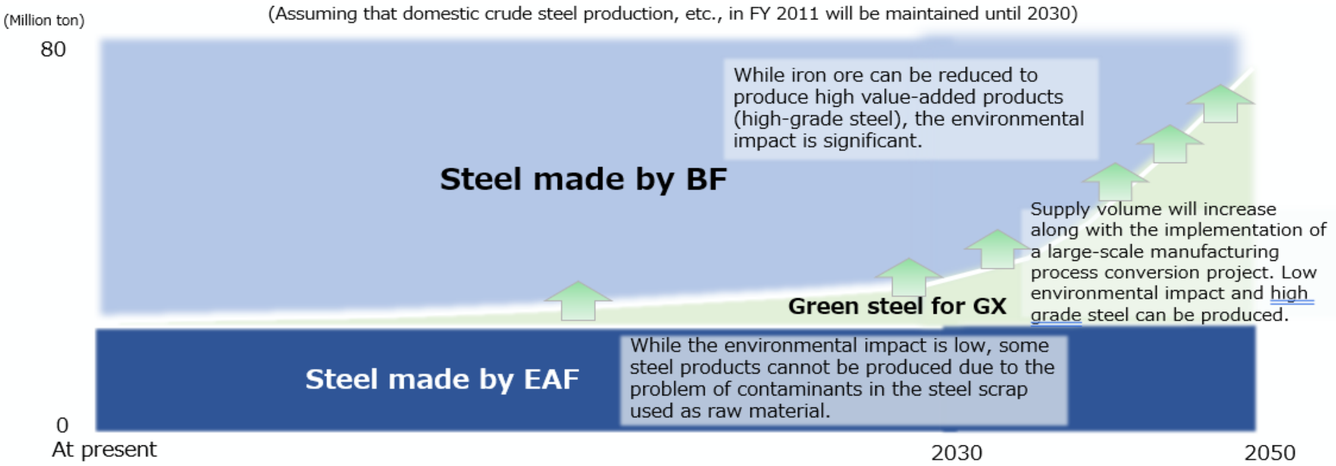
If GHG emissions from the blast furnace process are mitigated through GX investment in step-by-step manner, the steel market will feature a mix of steel products produced by the conventional blast furnace process and those produced through GX investment. Generally, the price of the latter is expected to be higher than that of the former. Additionally, steel products are commodities that are distributed internationally and imported from abroad. It is likely that steel produced by GX investment will not be purchased sufficiently or will not be sold at a price that reflects its production cost.

Table 3 Blast Furnaces Existing in Japan and Year of Construction, etc.

Company	Works	Blast Furnace（Start of operation）
Nippon Steel	North Nippon Works Muroran Area （Muroran, Hokkaido）	2nd BF（Start of 3rd operation in 2020）
	East Nippon Works Kashima Area （Kashima, Ibaraki）	1st BF（Start of 3rd operation in 2004） 3rd BF（Start of 3rd operation in 2007（Scheduled to cease operation in the end of 2024CY））
	East Nippon Works Kimitsu Area （Kimitsu, Chiba）	2nd BF（Start of 1st operation in 2012） 4th BF（Start of 1st operation in 2003）
	Nagoya Works （Tokai, Aichi）	1st BF（Start of 2nd operation in 2007） 3rd BF（Start of 2nd operation in 2022）
	Kansai Works Wakayama Area （Wakayama, Wakayama）	2nd BF（Start of 1st operation in 2019）
	Kyushu Works Yahata Area （Kitakyushu, Fukuoka）	4th BF（Start of 3rd operation in 2014）
	Kyushu Works Oita Area （Oita, Oita）	1st BF（Start of 4th operation in 2009） 2nd BF（Start of 2nd operation in 2004）
JFE Steel	East Japan Works Chiba Area （Chiba, Chiba）	6th BF（Start of 3rd operation in 2023）
	West Japan Works Kurashiki Area （Kurashiki, Okayama）	2nd BF（Start of 4th operation in 2003） 3rd BF（Start of 4th operation in 2010） 4th BF（Start of 4th operation in 2021）
	West Japan Works Fukuyama Area （Fukuyama, Hiroshima）	3rd BF（Start of 4th operation in 2011） 4th BF（Start of 4th operation in 2006） 5th BF（Start of 3rd operation in 2005）
Kobe Steel	Kakogawa Works （Kakogawa, Hyogo）	2nd BF（Start of 1st operation in 2007） 3rd BF（Start of 3rd operation in 2016）

Source: Compiled by METI from IR materials of each company

Figure 12 Image of decarbonization of the domestic steel industry



Source: Compiled by METI based on data from the Japan Iron and Steel Federation's Iron and Steel SupplyDemand Transition Chart (Fixed Report) and other sources.

The study group examined the policy direction regarding the support measures for steel products that have a significant environmentally favorable impact due to additional direct emission mitigation actions on a company-by-company basis. These products also experience a significant price increase compared to general products when the costs associated with these actions are included (hereinafter referred to as "Green Steel for GX").

There are two major approaches: one focuses on the production side, such as the steel industry, while the other addresses the demand side, including end users or industries that provide products and services to end users, such as the automobile and construction industry. Supportive and regulatory approaches can be applied to each side, respectively. Each approach is discussed below.

Response through carbon pricing (production side x regulation)

One logical measure to promote the use of Green Steel for GX would be to impose a monetary cost on steel products produced by conventional blast furnace processes (or on the companies that produce such steel) in proportion to the CO_2 emissions directly generated during the manufacturing process. This approach would allow steel products to be traded at prices comparable to the cost of Green Steel for GX.

On the other hand, there is currently a significant gap between the production cost of Green Steel for GX and that of other steel products produced using the conventional blast furnace process. If this price difference were to be addressed solely through a carbon pricing mechanism, such as an emissions trading system, it would require setting extremely high carbon prices from the inception of the scheme.

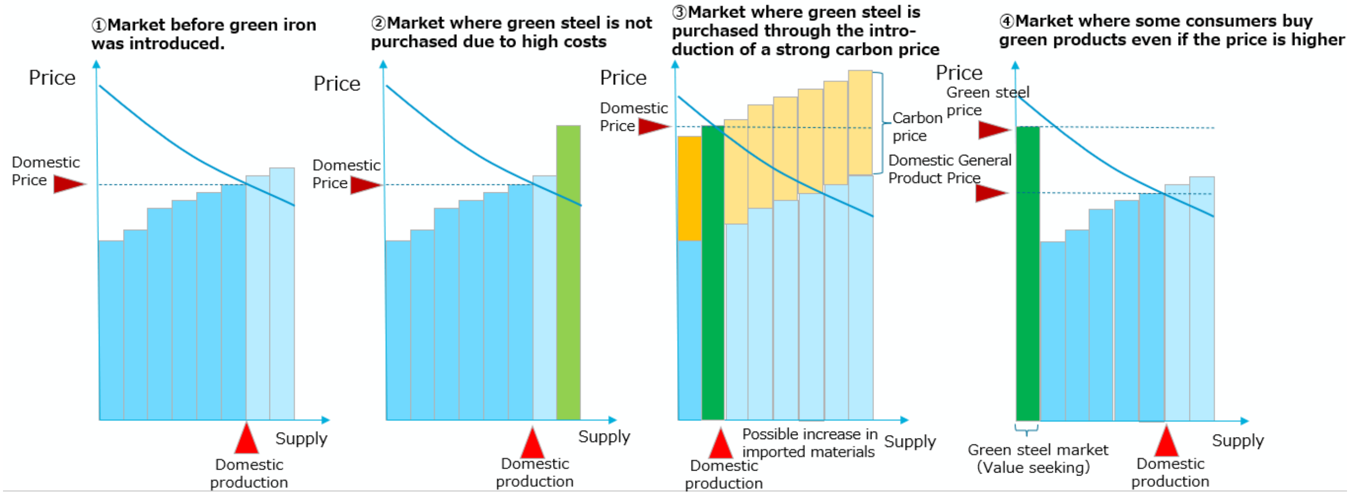
In this scenario, steel prices in Japan would rise, forcing users to procure steel at a significantly higher prices than currently, which could lead to increased costs for construction materials and automobiles, among other products. As a result, there are concerns that the impact on the Japanese economy and society could be substantial, particularly due to the reduced competitiveness of exported products, especially automobiles.

In light of this, Japan's growth-oriented carbon pricing concept advocates for the introduction of an emissions trading system alongside a fossil fuel surcharge system in tandem with upfront investment support of approximately 20 trillion yen, with the carbon price level to be gradually increased in a way that provides predictability.

In Europe, an emissions trading system was introduced early on. As free emission allowances for the steel industry are reduced in the future, the carbon price and the burden on the steel industry within the emissions trading system are expected to rise, with the EU Carbon Border Mechanism (CBAM) set to be implemented in 2026. When a high carbon price is established in Europe, CBAM will impose a monetary burden on steel imports from regions with no carbon price or low carbon prices, aiming to prevent carbon leakage,[11] where steel produced in Europe is replaced by imported materials. However, CBAM does not address the aforementioned issues caused by high carbon prices. Particularly in Japan's industrial structure, which exports many products such as automobiles, CBAM would be ineffective as it does not tackle the problem of reduced competitiveness of exported products.

Given these factors, the policy approach of expanding demand for Green Steel for GX by introducing a high carbon price and increasing the overall price of steel may not necessarily be effective, at least in the near future.

Figure 13 Relationship between carbon price and fostering a green iron market to promote GX



Support for production of Green Steel for GX (production side x support)

The government and other entities may provide support for the production of Green Steel for GX.

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[11] Although GHG emissions within the region appear to have been reduced, GHG emissions in the region where the imported steel products are produced will increase, resulting in no overall change in global emissions.

From this perspective, the government has established a program to support one-third of capital investment in projects aimed at reducing emissions in hard-to-abate industries and enhancing industrial competitiveness under the Energy and Manufacturing Process Conversion Support Program for industries in hard-to-abate sector.

In addition, the tax reform for FY2024 will introduce a corporate tax credit based on production and sales volume. The aim of this tax reform is to attract new domestic investment, particularly in areas where investment decisions are challenging due to high production cost. The tax credit for promoting domestic production in strategic sectors also includes the production and sales of green steel. However, the tax credit may not be fully proportional to the volume of production and sales, as it is capped at a maximum of 40% of the corporate tax paid by the eligible companies[12] .

As described above, measures have been established to enhance the production of Green Steel for GX; however, they do not fully cover the increase in production costs compared to steel produced through the conventional blast furnace process.

It is important to note that budgetary measures are subject to financial resource constraints and that the tax system to promote domestic production in strategic sectors is not a permanent scheme.

Encouraging the demand side of steel (demand side x regulation and support)

The use of Green Steel for GX could be encouraged and promoted on the demand side.

In May 2023, the EU amended its regulation on CO_2 emission standards for passenger cars and light commercial vehicles, stipulating that a report on the calculation rules for lifecycle CO_2 emissions of these vehicles shall be published by the end of 2025.[13] Starting in January 2026, reporting the life

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[12] The deduction is 20,000 yen per ton of green steel produced or sold. However, since the basic corporate tax rate in Japan is 23.2%, the deduction is virtually capped at 9.28% of taxable income (profit minus loss).

[13] Although not directly related to steel, the EU Battery Regulation came into force in Europe in August 2023. It includes regulations on GHG emissions throughout the entire life cycle of batteries (carbon footprint (CFP) regulation), responsible material procurement, and recycling, while also clarifying the implementation schedule for each aspect. The obligation to disclose the entire life

cycle CO_2 emission data of new cars to the EU Commission, based on these calculation rules, will be encouraged on a voluntary basis.

In November 2024, the Government of Japan convened the "Liaison Meeting of Relevant Ministries and Agencies on Life Cycle Carbon Reduction of Buildings". During the meeting, it was decided to proceed with studies in the direction of developing a LCA quantification method for buildings and establishing a corresponding system. Additionally, efforts will be made to accelerate the development of Environmental Product Declarations (EPDs) and other CO_2 emissions intensity data for building materials. A basic concept for the strategy to mitigate the life cycle carbon of buildings is to be formulated by the end of FY2024, which will be coordinated with the GX promotion policy.

Demand for green steel could be stimulated by introducing a system related to lifecycle CO_2 emissions for products and buildings that utilize steel.

In addition to government regulation, the adoption of green steel could be encouraged through private initiatives. The Science Based Targets initiative (SBTi), a joint initiative of WWF, CDP, the World Resources Institute (WRI), and the UN Global Compact, provides support and validation for companies setting targets to mitigate GHG. The SBTi claims that the participating companies which have already set targets or made commitments to the initiative account for approximately 40% of globally aggregated corporate value. As of the end of 2023, 840 companies in Japan had set targets or made commitments based on the SBTi. This number continues to grow in 2024.[14]

In the SBTi, companies are also required to set targets for reducing GHG emissions within their supply chains. Therefore, it is anticipated that companies participating in the SBTi will work to reduce CO_2 emissions throughout the life cycle of their products. As part of this effort, they are expected to promote the purchase of green steel.

The GX Leadership Declaration is an initiative designed to highlight companies that are actively using GX products and services and are contributing to early social implementation of these

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cycle carbon footprint will be introduced after February 2025, and market access for batteries with life cycle GHG emissions above a certain threshold will be restricted after February 2028.

[14] As of November 22, 2024, 1,351 companies have already set targets, and 89 other companies have pledged commitments.

products. This initiative aims to expand the market size for products and services that involve GX investment. The scope of the products in the GX Leadership Declaration includes green steel. The framework was established in December 2024, and by the end of that month, 12 companies had made declarations.

There is a movement within the government to purchase green steel through public procurement. The Ministry of the Environment's Study Group on Specified Procurement Items, under the Law on Promoting Green Procurement, has proposed establishing a cross-sectoral standard for government procurement of goods that use steel. The proposed standard assigns Criteria I to goods which utilize steel with quantified and disclosed CFP as well as Achieved Amount of Reduction (AAR). Criteria I in the procurement standard represents a prioritized category, recommending that the government procure these products as they meet higher environmental standards, provided there are no obstacles to procurement or supply restrictions when the two-step process is applied. In contrast, Criteria II establishes the minimum standard for procurement by each organization.

Concept of Support Measures for Green Steel for GX

To encourage demand, it is essential to establish a mechanism that promote emissions mitigations through visualization of the CFP when creating a market for decarbonized and low-carbon products (green products) aimed at achieving a carbon neutral society. The CFP represents the amount of CO_2 emissions associated with a company's products throughout the supply chain, quantified from the perspective of LCA.

In addition, when promoting GX, it is important to focus on Achieved Amount of Reductions (AAR) and Amount of Contributions to Reductions (ACR). AAR is an indicator that reflects the achieved amount of emission mitigation through measures implemented by the company. This concept was introduced in the interim report of “Study Group on GX Product Markets that Contribute to Creating Demand to Strengthen Industrial Competitiveness and Reduce Emissions (March 2024)”. The interim report, hereinafter referred to as the "Interim Report of Study Group on GX Product Markets," emphasized that AAR and ACR are important indicators and should be evaluated alongside CFP to represent “GX value” and effectively appeal to the demand side through the value chain.

This study group believes that it is important for GX value, such as AAR, to be evaluated on the demand side in addition to CFP, aligning with the perspective of the Interim Report of Study Group on GX Product Markets.

The steel industry is generally characterized by the fact that the electric furnace process, which uses steel scrap, has lower GHG emissions during production, while the blast furnace process, which reduces iron ore, results in higher GHG emissions.

Obviously, steel scrap does not originally exist in nature; it consists of steel materials that were reduced from iron ore in the past through blast furnace processes. It is indisputable that steel scrap should be utilized to the maximum extent possible. In addition, Japan has actively adopted policies to promote the effective use of resources, including construction recycling, automobile recycling, and home appliance recycling. We should continue these efforts, and also focus on the active use of steel products obtained from electric furnace processes, as well as expanding their utilization[15].

On the other hand, simply continuing to use steel products obtained from electric furnace processes that utilize steel scrap, which is already being effectively utilized today, will hardly contribute to further reductions in GHG emissions in Japan or globally. As indicated by estimates from the International Energy Agency (IEA) and other sources, the reduction of iron ore will be necessary for decades to come due to increasing steel demand and projected steel scrap generation. Mitigating GHG emissions from the process that involve iron ore reduction in blast furnace and other processes will be essential for decarbonizing the steel industry. Such efforts are critically important for achieving a carbon-neutral society.

Moreover, such efforts to decarbonize the blast furnace process will not arise spontaneously from economic rationality, as they require significant capital investment and higher production costs. These efforts can only be realized if society strongly encourages the promotion of GX in the steel industry. Therefore, in addition to the government implementing certain support measures[16] , it is highly

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[15] It was suggested that when a business introduces an innovative electric furnace, it should receive recognition for its contribution to the reduction of GHG emissions across society.

[16] As mentioned earlier, the government is supporting GX investment in the steel industry through the Green Innovation Fund to support technology development, projects to support energy and

desirable to create a mechanism that enables the demand side to recognize the importance of promoting GX and to support such efforts through the value chain.

The term “Achieved Amount of Reductions (AAR)” was newly proposed in Japan in the Interim Report of the Study Group on GX Product Markets. However, it is globally recognized that decarbonizing industrial processes and achieving a carbon neutral society cannot be accomplished solely by continuing conventional energy conservation and electricity decarbonization efforts; it requires technological innovation and large-scale investment in manufacturing processes.[17] Discussions to support such efforts are currently taking place, particularly among environmentally conscious companies.

It is true that CFP has been widely used as an indicator to represent the environmental value of a product, and it is easier to gain the understanding of end consumers by appealing to them with a low CFP. The automobile industry, one of the major consumers of steel products, exports its vehicles to the European market, where the voluntary calculation of CFP for sold vehicles is expected to be required. Automobile industry has a strong interest in steel products with low environmental impact. Similarly, the real estate and construction industries are also interested in steel products with low environmental impact to attract investment in domestic real estate, such as buildings and data centers. Considering the needs of the automobile and real estate industries, it is desirable for Green Steel for GX to be internationally recognized as a product with a low CFP in foreign markets, including the European market. User industries are interested in products that can help lower disclosed emission data on a company-by-company basis.

The relationships between GX value and CFP will be discussed in detail in the next chapter.

Based on this, the Study Group believes that the following directions will support Green Steel for GX as well as low CFP steel.

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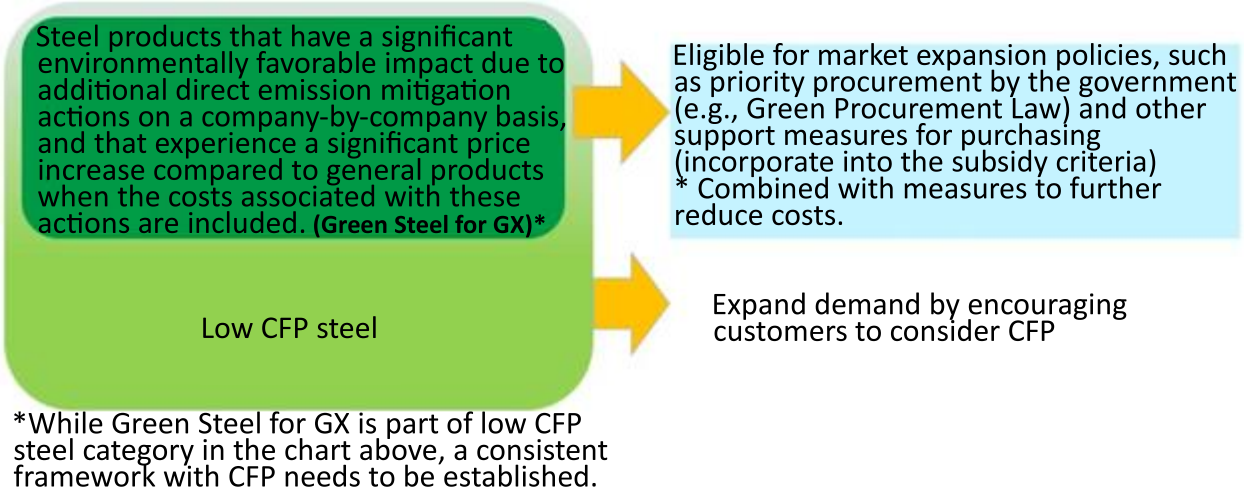
manufacturing process conversion in industries where emission reductions are difficult to achieve, and tax incentives to promote domestic production in strategic sectors.

[17] For example, the IEA's Net Zero Emissions by 2050 Scenario estimates that $4.5 trillion in clean energy investment will be needed by 2030 to achieve Net Zero emissions. The analysis also indicates the need to develop and expand the use of hydrogen-reduced ironmaking technology and other technologies in the steel manufacturing process.

Figure 14 Concept of support for Green Steel for GX and low CFP steel



First, by encouraging customers to consider CFP, the overall use of steel products with low environmental impact should be expanded. In addition, Green Steel for GX —defined as steel products that have a significant environmentally favorable impact due to additional direct emission mitigation actions on a company-by-company basis, and that experience a significant price increase compared to general products when the costs associated with these actions are included—should be eligible for market expansion policies, such as priority procurement by the government and other support measures for purchasing these products.

In addition, if a consistent framework could be established between low CFP steel and Green Steel for GX, it would lead to more cost-efficient policy. Therefore, we anticipate further serious discussions on the relationship between GX value and CFP among experts and stakeholders in Japan and abroad. Both the public and private sectors should work together to propose a concrete framework and provide necessary information to encourage the domestic and international discussions aimed at developing international standard, etc.[18]

[18] The automobile industry also pointed out that it would be desirable to establish an emissions calculation system on the premise that it would be recognized globally as soon as possible. (Presentation by the Japan Automobile Manufacturers Association at the 3rd workshop)

Then, if deemed appropriate as a result of discussions among experts, formulating national product-specific calculation rules for CFP of steel products should be considered in a way that reflects such discussions. The outcome of the discussion could also be incorporated into the Japan's CFP guidelines. In addition, consideration should be given to adopting these rules in governmental policies related to building LCA and other areas.

GX investments generally require a lead time of about five years or even longer, and there is virtually no time to waste in forming concrete GX projects in the steel industry that is to be realized by the late 2020s. The automobile industry has highlighted the urgent need to prepare for the decarbonization competition expected to intensify in the late 2020s[19]. To encourage GX investment decisions, it is important for relevant business entities to have a certain level of predictability regarding policy direction at the time of their investment decisions. Therefore, the government should outline its policy direction on support measures at this early stage.

Achieving international standardization through expert discussions on CFP will take time. Based on the premise that efforts should be made to establish standards and rules linking Green Steel for GX to its value in terms of CFP, support measures for both the supply and demand sides of Green Steel for GX should be considered and formulated now, with the aim of stimulating demand for Green Steel for GX in a timely, step-by-step manner.

[19] Presentation by the Japan Automobile Manufacturers Association at the 3rd Meeting.

Chapter 4: Green Steel for GX and CFP

Discussion in the ISO (International Organization for Standardization)

As mentioned earlier, CFP is a calculation of CO_2 emissions in the supply chain of a company's products from a life cycle assessment (LCA) perspective.

The International Organization for Standardization (ISO) has standardized LCA calculation methods (ISO 14040:2010, ISO 14044:2010). Among these, “ISO 14040:2010 Environmental management - Life cycle assessment - Principles and framework” defines the general principles and framework for conducting a quantified environmental assessment. The specific requirements for each procedure are outlined in “ISO 14044:2010 Environmental management - Life cycle assessment - Requirements and guidelines.” ISO 14044:2010 provides a framework for assessing not only the environmental impact of GHG, but also a wide range of other environmental impacts, such as chemical substance management and biodiversity.

On this basis, to provide better understanding to identify opportunities for increases in GHG removals and reductions of GHG emissions, standardization of CFP has been established as the framework for quantifying GHG emissions and removal over the life cycle of a product or service in “ISO 14067:2018 Greenhouse gases -Carbon footprint of products - Requirements and guidelines for quantification.”

In addition, ISO 14064-1:2018, ISO 14064-2:2019, and ISO-14064-3:2019 have been developed by ISO to detail the principles and requirements for the quantification, reporting and validation of the GHG.

ISO 14064-1:2018 provides the standard for quantifying and reporting the inventory of GHG emissions and removals at the organizational boundary. The GHG emissions inventory at this boundary must be consistent with CFP in a broad sense. Therefore, this standard is important for CFP quantification.

ISO 14064-2:2019 provides the standard for quantifying GHG emission reductions and removals strictly associated with a project aimed at emission reduction or removal, relative to baseline GHG emissions, if such a project is implemented.

ISO 14064-3:2019 primarily provides a set of rules for certification bodies when verifying CFP, organizational inventories, and GHG emission reductions for specific projects.

Table 4 ISO Standards for CFP and Greenhouse Gas Calculations

	Quantification and reporting rules	Concerning ISO standards	Description
1	Carbon footprint (CFP)	ISO 14067:2018	Rules for the quantification of GHGs emissions and removal throughout the life cycle of a product, aiming to provide a better understanding of opportunities for increasing GHG removals and reducing GHG emissions, and to facilitate the implementation of a GHG management strategy
2	GHG inventories at the organization level	ISO 14064-1:2018	Rues for developing and reporting organization-level GHG inventories regarding GHG emissions and removal
3	GHG emission reductions or removal enhancements at the project level	ISO 14064-2:2019	Rules for quantifying and reporting emission reductions and/or removal enhancements by comparing GHG project emissions/removals with the baseline scenario
4	Verification and validation of greenhouse gas statements	ISO 14064-3:2019	Rules for verifying GHG statements related to CFP, GHG inventories, GHG projects

In this way, the methodology for calculating CFP has been established to a certain degree and standardized by ISO.

Status of Discussions in International Initiatives

The GHG Protocol Initiative, established by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI), is developing the GHG Protocol, a standard for quantifying and reporting GHG emissions.

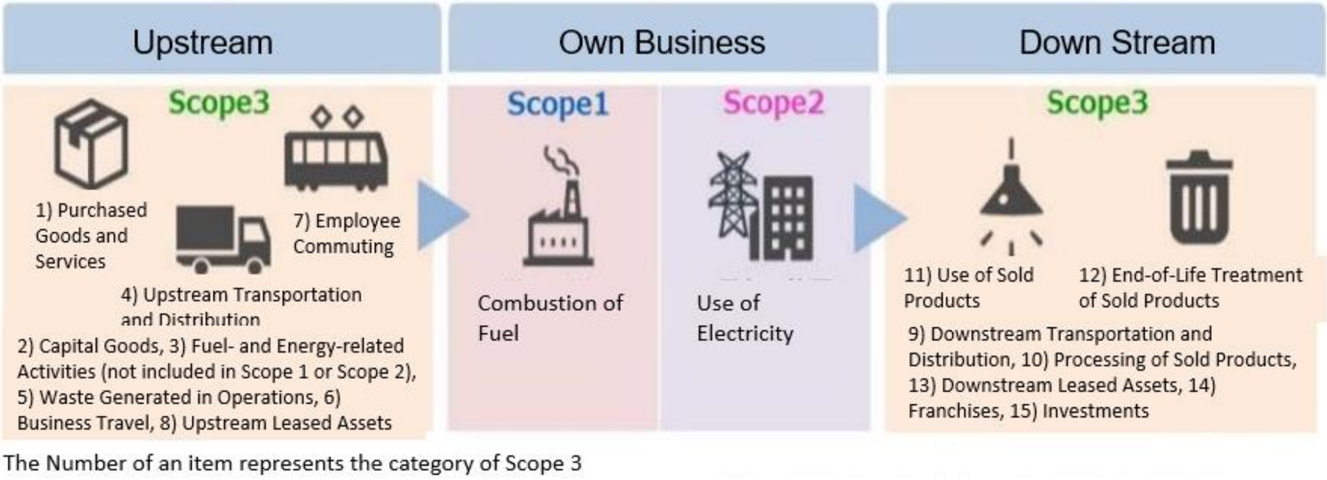
The GHG Protocol classifies corporate emissions into Scope 1, Scope 2, and Scope 3 as follows.

Scope 1: Direct GHG emissions from the business itself (fuel combustion, industrial processes etc.)

Scope 2: Indirect emissions from the use of electricity, heat, and steam supplied by other companies

Scope 3: Indirect emissions that are not included in Scope 1 and Scope 2 (emissions from the activities of other companies related to the business)

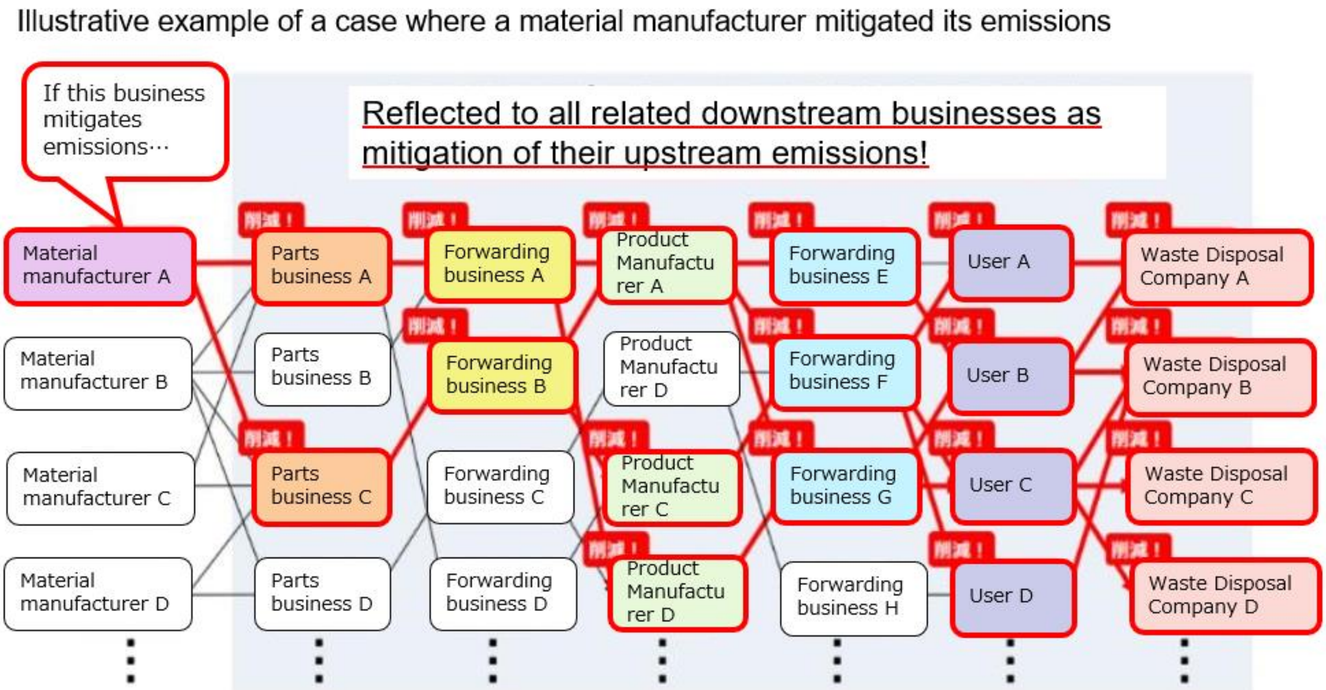
Figure 15 Concept of Scope 1,2, and 3 in the GHG Protocol



Source: Ministry of the Environment data (posted on the Green Value Chain Platform)

Scope 3 quantifies emissions in the supply chain, including those from raw materials. Therefore, mitigations conducted upstream in the supply chain will lead to emissions mitigations downstream.

Figure 16 Impact of GHG Mitigations in the Materials Industry on Scope 3 for Downstream Supply Chain Operators



Source: Ministry of the Environment data (posted on the Green Value Chain Platform)

The GHG Protocol is currently undergoing revision, with a draft expected to be released in 2026. Regarding issues related to green steel, the GHG Protocol has clarified that the market-based method can be used for Scope 2 emissions, but it has not yet specified whether this method can be applied to value chain emissions (Scope 3). In this context, during the opinion solicitation procedure conducted by the Secretariat of GHG Protocol, some submissions advocated for the use of the market-based method for Scope 3 as well, while others expressed opposing views on these proposals.

SBTi is a joint initiative by WWF, CDP, WRI, and the UN Global Compact that provides support and validation for companies setting GHG reduction targets. The SBTi adopts standards based on the GHG Protocol, so any future revisions to the GHG Protocol may influence the behavior of companies participating in the SBTi.

Regarding the rules for quantifying Scope 3 emissions, SBTi published a discussion paper in July 2024 on how to utilize the Environmental Attribute Certificate (EAC) [20] for climate change targets within the corporate value chain.

According to the SBTi discussion paper, there are currently no established norms regarding the extent of traceability required in the value chain for emission mitigation actions to validate environmental claims. While noting that the most robust models for establishing traceability are identity preservation and physical segregation, and that the book-and-claim model is an approach on the opposite end of the spectrum, the paper examines the use cases of certificates and EAC in corporate emission mitigation strategies and discusses the risks and considerations associated with five different scenarios.

[20] The discussion paper states that Environmental Attribute Certificates (EAC) includes carbon credits and commodity certificates.

Table 5 Proposed Use of Commodity Certificates in SBTi Discussion Paper

	Scenarios	Risks	Note
1	Use of commodity certificates from value chain activities	✓ N.A. (a robust chain of custody is crucial to enable traceability)	
2	Use of commodity certificates from sources with lower or no value chain traceability	✓ Risk of not effectively contributing to additional mitigation efforts. Risk of resulting in a lower amount of mitigation finance. ✓ Reduced incentive for corporates to remove barriers ✓ Risk of potentially misleading stakeholders	✓ Limits to high-quality certificates from sources that can demonstrably lead to net-zero aligned outcomes ✓ Gradually shifts towards other chain of custody models. ✓ Require a claims system that leads to transparent and accurate claims
3	Use of carbon credits from mitigation activities within the value chain to substantiate value chain emission reduction claims	✓ Additional guidance is needed on appropriate claims for entities mitigating an emission in the supply chain. (SBTi standards require that carbon credits are not counted as emission reductions)	✓ Require further exploration in the use case of carbon credits
4	Use of carbon credits to support neutralization of residual emissions	✓ Carbon credits from GHG removal activities are a potential means to finance the neutralization of these residual emissions, while some of the key concepts need to be explored.	✓ Some of the areas to be explored includes the point that the type of carbon removal may need to matches the type of emission.
5	Use of carbon credits to support beyond value chain mitigation	✓ Risk of leading to stakeholder, while this approach might contribute to mitigation finance ✓ Risk that purchasing of carbon credits does not contribute to additional mitigation efforts.	✓ Supply-side may set quality criteria to ensure that carbon credits represent verifiable ✓ Additional eligibility criteria, such as limiting the vintage of carbon credits, may be considered

Source: Prepared by the Secretariat based on SBTi RESEARCH: SCOPE 3 DISCUSSION PAPER, "ALIGNING CORPORATE VALUE CHAINS TO GLOBAL CLIMATE GOALS" (July 2024). Prepared by the secretariat. Risks and points to note have been simplified to a certain extent.

The terms “individual preservation” and “physical segregation,” mentioned in the SBTi discussion paper, are concepts defined in the so-called chain of custody rules.

Chain of Custody is a system designed to ensure the traceability of the required characteristics of raw materials throughout the supply chain. The related standard, ISO 22095:2020, was published in October 2020.

ISO 22095 specifies five models. Among these, a working group (ISO/TC 308/WG 2) has been established to discuss the standardization of the mass balance model and the book-and-claim model.

Table 6 Concept of Chain of Custody in the Processing and Distribution Process

Term	Description
1) Identity preservation	A product or material is linked to its original source without any mixing with other materials, ensuring that the specific characteristics of the product are maintained from the source to the final product.
2) Segregation	Specific characteristics of the product is maintained throughout the supply chain.
3) Controlled blending	Mixing of certified and non-certified materials according to a specified standard, ensuring that the end product contains a known proportion of certified material.
4) Mass balance	Certified materials are mixed with non-certified materials according to the standard that the total output of certified products cannot exceed the input of certified materials.
5) Book and claim	The physical flow of materials in the supply chain is separated from the flow of sustainability claims.

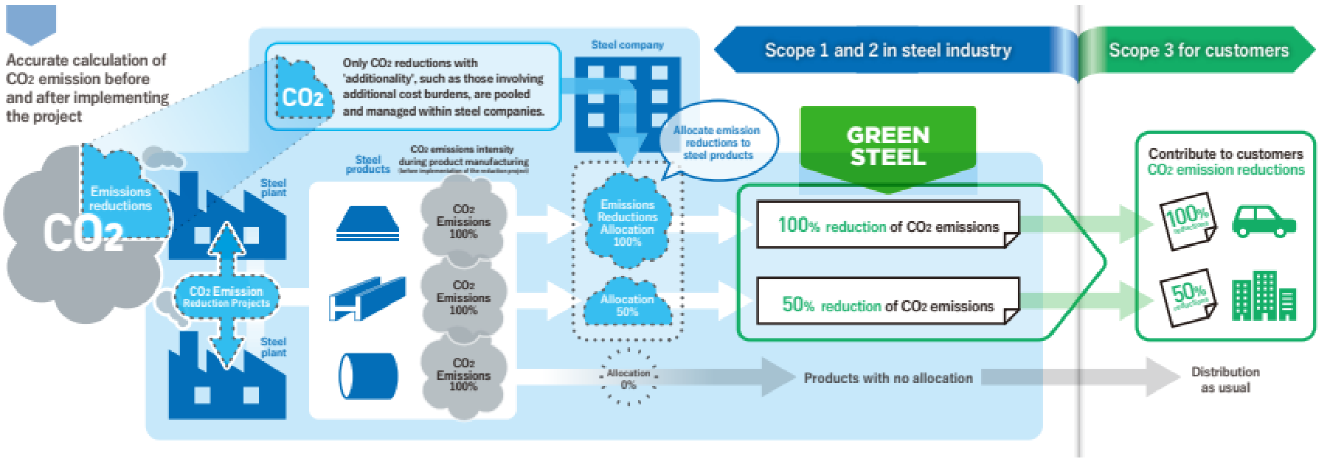
Source: Prepared by the secretariat of the working group with reference to the Japanese Standards Association Group website (ISO/TC 308) (https://webdesk.jsa.or.jp/common/W10K0500/index/dev/isopc_308/?dev/isopc_308/)

Proposal by the Japan Iron and Steel Federation

The Japan Iron and Steel Federation (JISF) has published the "Guideline on Green Steel". This guideline outlines the rules for allocating the amount of CO_2 emission mitigations to steel products from the total CO_2 emission mitigations managed and pooled within a steel company. This allocation applies when the steel company implements a CO_2 reduction project with "additionality" such as incurring additional cost burdens, and when it quantifies the accurate difference in CO_2 emissions before and after implementing the project.

The CFP of steel products, prior to the allocation of CO_2 mitigations, is quantified based on the rules outlined in the ISO standards. The amount of CO_2 emission mitigations, which represents the difference in CO_2 emissions before and after implementing a CO_2 mitigation project, should also be quantified according to the rules in the ISO standards. Subsequently, the amount of CO_2 mitigations is converted into certificates, which are then allocated to the products up to the total amount of CO_2 mitigations.

Figure 17 "Guidelines on Green Steel" advocated by the Japan Iron and Steel Federation



Source: Japan Iron and Steel Federation, "Green Steel Upon the Application of the Mass Balance Approach"

Green steel adopting similar methodology is being sold by European steel companies.

ArcelorMittal (Xcarb steel certificate), ThyssenKrupp (bluemint pure), and Tata Steel Europe (Zeremis Carbon Lite) offer green steel products that come with allocated amount of CO_2 mitigations. According to DNV, the Norwegian third-party certification body that certifies these green steel products, the amount of CO_2 mitigations is allocated based on a book-and-claim (or mass balance) method.

In November 2024, worldsteel, an association of steel companies from around the world, published guidelines for using a Chain of Custody model for GHG emissions mitigation in the steel industry. While worldsteel's guidelines differ from those of the JISF in certain details, such as the concept of additionality and the effective period of the AAR (Achieved Amount of Reductions), both guidelines share the common position of allowing steel companies to allocate the AAR in CO_2 emissions to their products.

As mentioned in the previous section, in light of the difficulties associated with enhancing industrial decarbonization, the SBTi and other initiatives have begun discussions on how to utilize EAC as a strategy for reducing GHG emissions in the supply chain. In Japan, as indicated in the Interim Report of the Study Group on GX Product Markets, it is important for the demand side to contribute to the decarbonization of the industrial sector by focusing on the AAR in GHG emissions. Building on these discussions, we hope that Green Steel Guidelines advocated by the JISF will be widely accepted both in Japan and abroad, and that they will be reflected in international standards and policies related to the decarbonization of the steel sector.

On the other hand, while the JISF's Green Steel Guidelines focus on the AAR in GHG emissions and allows a steel company to allocate the AAR from the total emissions reductions in accordance with its sales policy, it remains unclear how this treatment fits within the concept of CFP.

In this regard, the JISF proposed a modification to the treatment in the JISF guideline to ensure the compatibility with the concept of CFP. Annex 4 covers the proposal made by the JISF.

The proposal by the JISF aims to provide incentives in the form of reduced GHG emissions per unit of product (CFP) to customers who wish to support the realization of a decarbonized society by purchasing Green Steel for GX during the transition period of decarbonization. At the Study Group, several members expressed their support for the JISF's proposal.

We believe that the appropriateness of these methods should be left to the experts, considering the concept of LCA, CFP, as well as GX promotion. If the results of the discussions among experts are positive, one option to consider is the formulation of product-specific CFP quantification rules for steel products that reflect these discussions. In that case, the rules in the Japan's CFP guidelines may also be modified accordingly. Additionally, it is conceivable to adopt this concept in governmental policies, such as building LCA.

In addition, for user industries of steel, such as the automobile industry, which exports products to foreign markets like Europe, or the real estate industry, which attracts investments from abroad, it is important to establish international standards applied to Green Steel for GX. These standards should recognize Green Steel for GX which reflects the implemented emission reduction action as having low CFP. This can be achieved through the collaborative efforts of the public and private sectors to cultivate international understanding on the concept of the Green Steel for GX. For this purpose, it is important to develop a framework that ensures the JISF's proposal and the methodology reflecting the concept of mass balance and book-and-claim in ISO 22095:2020 (Management of processing and distribution processes - general terms and models) are compatible with CFP. We will also work to incorporate these methodologies into various rules both in Japan and abroad.

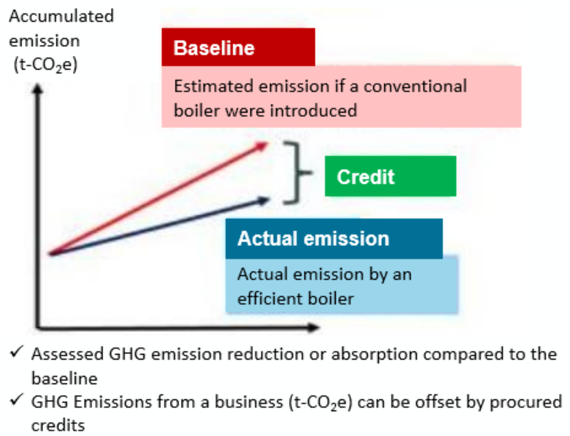
To implement the JISF's proposal, it is necessary to further refine details such as operational rules. Additionally, related businesses need to prepare data related to CFP. Furthermore, when the JISF's proposal is put into operation, it is important to disclose appropriate information to the demand side, including consumers, and to engage in activities that promote understanding of Green Steel for GX.

Column 2: Carbon Credits

Carbon credits evaluate the achieved amount of CO_2 emission mitigations and creates economically tradable form for that achievement. In other words, the carbon credits system quantifies the AAR of GHG emission, and converts it into tradable credits. In Japan, the Ministry of Economy, Trade and Industry (METI), the Ministry of the Environment (MOE), and the Ministry of Agriculture, Forestry and Fisheries (MAFF) administer the J-Credit program, which has been in operation since 2013. Carbon credits are certified for a wide range of activities, including energy conservation, renewable energy, and forestry.

Carbon credits may also be used to adjust an organization's total emissions (Scope 1 and 2). Under the Global Warming Countermeasure Law, carbon credits (limited to those permitted under the program) can be procured and deducted in the calculation of “adjusted GHG emissions”. If a business generates carbon credits and then transfers them to another business, the amount transferred must be added to the “adjusted GHG emissions” in the calculation and reported to the government.

Figure 18 Credit Concept



Source "Carbon Credit Report," Study Group on Environmental Improvement for Appropriate Use of Carbon Credits to Achieve Carbon Neutrality (June 2022)

The CO_2 Reduction Certificates in the Green Steel Guidelines by the JISF are not intended to be distributed on their own. The guidelines also state that CO_2 Reduction Certificates can be used for Scope 3 emissions reductions, rather than carbon credits used to adjust total emissions at the organizational level (Scope 1 and 2), by purchasers of steel products.

Column 3: Supporting the efforts of companies in the supply chain

Carbon insetting refers to a company's effort to support the emission reduction actions of other companies with the aim of reducing supply chain emissions associated with their products or services. A typical example is when a company supports afforestation efforts or utilization of renewable energy by other companies involved in its supply chain. [21]

As part of these activities, initiatives such as the use of biofuel in the air freight forwarding industry are beginning to emerge. Shippers support the use of biofuels by freight forwarders and pay a premium on top of regular shipping costs. Although air cargo carriers do not physically use biofuels that transport shippers' actual cargo, they receive a premium based on the amount of biofuels they actually use, utilizing a book-and-claim method.

Electricity certificates are sometimes regarded as a use case for book-and-claim method.

[21] As described by the World Economic Forum (https://www.weforum.org/stories/2022/03/carbon-insetting-vs-offsetting-anexplainer/)

Chapter 5: Looking Ahead

Based on the previous discussions, the Study Group considers it appropriate to address the following points.

1) Promote GX value and ensure it reflected in international standards and related frameworks.

   To decarbonize the steel industry and achieve a carbon neutral society, it is essential to reduce GHG emissions during the reduction of iron ore. We will work to promote understanding on the demand side regarding the importance of significantly reducing GHG emissions from the conventional process through GX investment.

   In this regard, we will collaborate with worldsteel and private-sector international initiatives to widely share the importance of evaluating GHG reductions in the supply chain with relevant stakeholders, both inside and outside Japan. We will also encourage the steel industry to engage in activities that promote understanding.

   In addition, we will further examine the approach proposed by the JISF that provides the methodology for evaluating Green Steel for GX as a product with a low CFP under international standards such as ISO. We will further promote discussion on the methodology among CFP experts inside and outside Japan by encouraging both the public and private sectors to propose a concrete framework and provide necessary information.

   In doing so, we will also collaborate with the GHG Protocol, which is widely used both domestically and internationally as a method for quantifying GHG emissions, and coordinate our efforts with discussions in international standardization work such as those conducted by the ISO.

   We believe that the appropriateness of the framework should be left to the experts, considering the concepts of LCA, CFP, as well as GX promotion. If the results of the discussions among experts are positive, one option to consider is formulation of product-specific CFP quantification rules for steel products that reflect these discussions. In that case, the rules in the Japan’s CFP guidelines may also be modified accordingly. Additionally, it is conceivable to adopt this concept in governmental policies, such as building LCA.

2) Enhance the utilization of CFP for steel products

After conducting activities to promote understanding of the importance of GX value, we should encourage the demand side to utilize CFP to expand the overall use of steel products[22] that have a low environmental impact. In these efforts, steel products produced from steel scrap using the electric furnace process should also be utilized as effectively as possible.

When a method for evaluate GX value in a manner consistent with the existing CFP approach is established, the enhanced use of CFP will also contribute to the increased adoption of Green Steel for GX, leading to more cost-efficient policy implementation.

The steel industry is also required to develop and disclose data related to CFP for steel products.

Steel products that utilize electricity with NFC (non-fossil certificates) should be discussed from the perspective of energy policy aimed at expanding non-fossil energy. This topic is not the primary focus of this study group, which has mainly concentrated on reducing GHG emissions directly emitted from the steel industry through GX investment. However, various methods for using NFC with steel products, particularly regarding how to allocate NFC to these products, can be considered. It is anticipated that the issue will be intensively discussed and examined within the steel industry to ensure the transparency in the operation of NFC usage with steel products.

3) Provide government support for Green Steel for GX, including measures for the demand side

Although the government is providing support for technological development, capital investment, and taxation measures during production for Green Steel for GX[23], prices for Green Steel for GX are still expected to rise due to higher raw material and energy costs compared to conventional products. Therefore, at least in the early stages, we need to focus on policies such

[22] There was a suggestion that even among low-CFP steel products, they should be classified according to their CFP values.

[23] In this report, the term "Green Steel to promote GX" is used as steel products that have a significant environmentally favorable impact due to additional direct emission mitigation actions on a company-by-company basis, and that experience a significant price increase compared to general products when the costs associated with these actions are included.

as preferential procurement and government support for purchases to help expand the market of Green Steel for GX.

Specifically, in addition to the government's preferential procurement under the Green Procurement Law, CEV[24] subsidy program, which are subsidies to consumers, should provide incentives for automobile manufacturers (OEMs) who commit to using steel with a low environmental impact so that the OEMs systematically adopt Green Steel for GX and contribute to the decarbonization of the steel industry.[25]

It is important to promote understanding among end-users and other stakeholders on the demand side regarding the importance of significantly mitigating GHG emissions from conventional processes through GX investment. Therefore, in establishing support measures and incentives for market expansion, it is appropriate to seek cooperation from program participants in activities aimed at raising awareness about the expanded use of Green Steel for GX among the demand side, including end-users.

4) Promote technology development and effective utilization of steel scrap

While Green Steel for GX tends to be more expensive than conventional products, especially in the early stages, we will consider measures to further reduce costs. In addition, we will continue to support the supply side through multi-track technological development, capital investment support, tax measures, and other initiatives.

We will also promote the effective utilization of steel scrap through enhanced cooperation among related businesses.

Although the Study Group on Green Steel for GX will conclude its activities with this report, it would be meaningful to review the progress of efforts to expand the market for Green Steel for GX and to discuss further measures at a forum like this study group, which includes participation from both

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[24] CEV: Clean Energy Vehicle

[25] In addition to valuing the procurement of Green Steel to promote GX, it is appropriate to assign a certain value to actions to procure steel products with low environmental impact as a contribution to decarbonization.

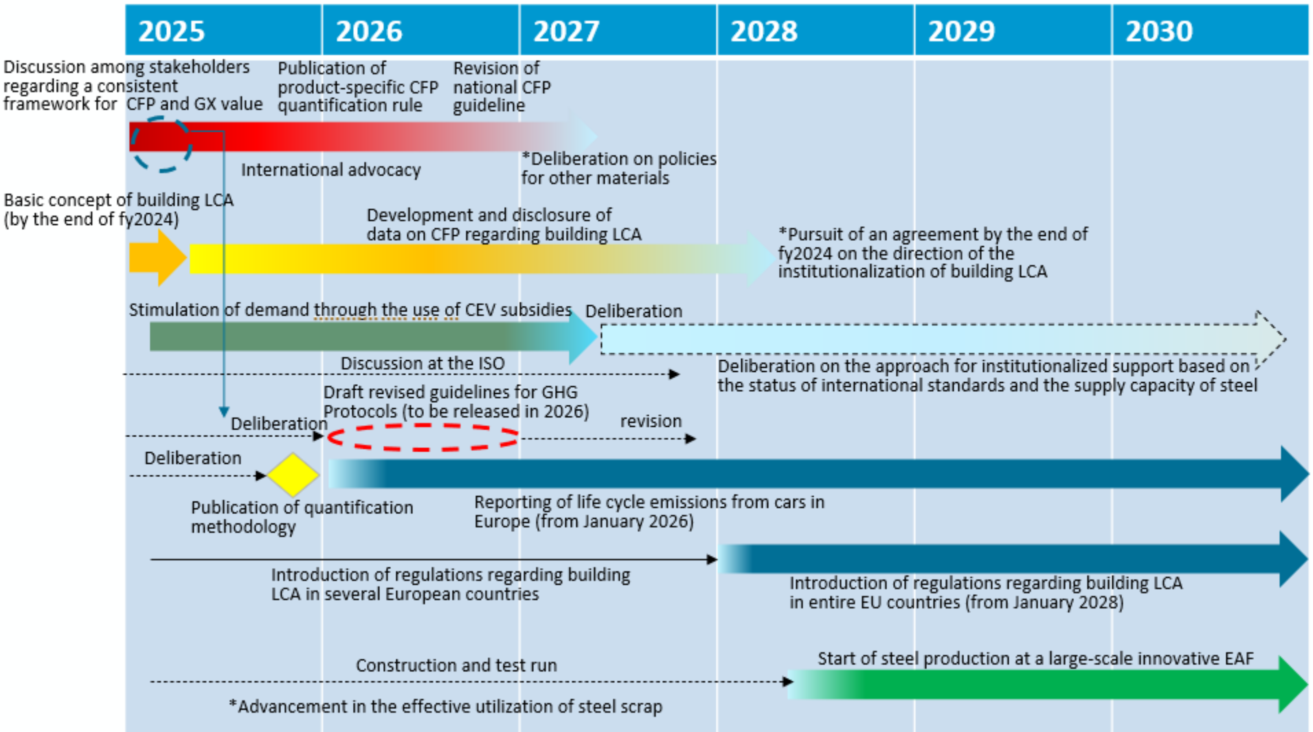
the user industry and the steel industry. After the completion of this Study Group, METI will continue these efforts in cooperation with related ministries and agencies.

In addition, in the automobile and construction industries, many materials other than steel are combined to produce end products and construct buildings. Given the need for CFP for final products and buildings to be quantified based on international standards, it is desirable to monitor the progress toward formulation of rules for certification and labeling of values, such as GX value, for other materials as well.

GX investments for actual decarbonization projects in the steel industry are about to be made domestically. As the need for decarbonization in the steel industry gains strong global recognition, the deliberation of relevant rules is set to begin. Actions taken at this time are of great significance for expanding the market for Green Steel for GX. Based on the deliberations of this study group, it is essential for the government and related parties to take immediate action.

Figure 19 Future actions to expand the market for green iron for GX promotion

*This diagram is intended to raise the awareness of the need for immediate action by all parties concerned. It is not intended to imply that the future actions have already been scheduled according to the diagram.



Appendix 1 Reduced iron

Introduction

Iron exists in nature in the form of iron ore (iron oxide, such as Fe_2O_3), and it is extracted through reduction process. (See Chapter 1.)

In the conventional blast furnace process, the reduction of iron ore and the melting of the iron content to produce pig iron occur within the same process. However, as society increasingly calls for the decarbonization of steelmaking, attention is turning to direct reduction ironmaking, which has traditionally been prevalent in regions where natural gas is readily procured.

Specifically, iron ore is fed into a direct reduction plant, where natural gas or hydrogen gas is introduced to remove oxygen from the iron ore. The resulting direct reduced iron (DRI) is then melted in an electric furnace.

If iron ore is reduced using hydrogen gas and an electric furnace powered by CO_2-free electricity is used in the subsequent melting process, the ironmaking process can be considered virtually CO_2-free. However, current technology has limitations, as a significant proportion of iron(Fe) can be lost into slag when DRI derived from low-grade iron ore with low Fe content or high impurities, such as SiO_2 and Al_2O_3, is processed in an electric furnace.

Classification of Iron Ore

Iron ore is classified into several types based on grain size.

Lump ore (1) --- 6.3 mm to 32.0 mm in diameter, fed directly into the blast furnace.

Sinter Feed (SFF) (2) --- 0.15mm to 6.3mm in diameter. Lump ore is crushed and beneficiated to a certain degree. SFF has a large circulation. Although it must be sintered before being fed into a blast furnace, it has become the most commonly used type of iron ore by Japanese blast furnace makers as sintering technology has improved. Limestone is added to sinter feed and baked at 1300 degrees Celsius to make a uniform mass of 5 to 25mm called sintered ore (4).

Pellet Feed (PFF) (3) --- 0.15 mm or less in diameter. Pelletized before being fed into a blast furnace. Pellet feed is added with water and a binder to form 10 to 30 mm spheres, which are then baked and hardened. These pellets are called pellets (5). In a direct reduction furnace, the pellets are reduced with gas, etc. The reduced iron is called DRI (Direct Reduced Iron) (6). Briquetted DRI is called HBI (Hot Briquetted Iron) to reduce the risk of ignition during long-distance transportation.

Figure 20 Various types of iron ore

(1) Lump ore

(2) Sinter feed

(3) Pellet feed

(4) Sintered ore

(5) Pellets

(6) DRI (Direct Reduced Iron)

Source: Explanatory Material at the Second Meeting of Study Group on Green Steel for GX

The grade of iron ore

Iron ore contains impurities as well as iron (Fe). These impurities significantly affect the quality of steel, making their removal and control important factors in the steelmaking process. For example, silica (SiO_2) has a high melting point and consumes more energy when its content is high. Other impurities such as phosphorus (P) and sulfur (S) are also known to adversely affect the quality of steel products.

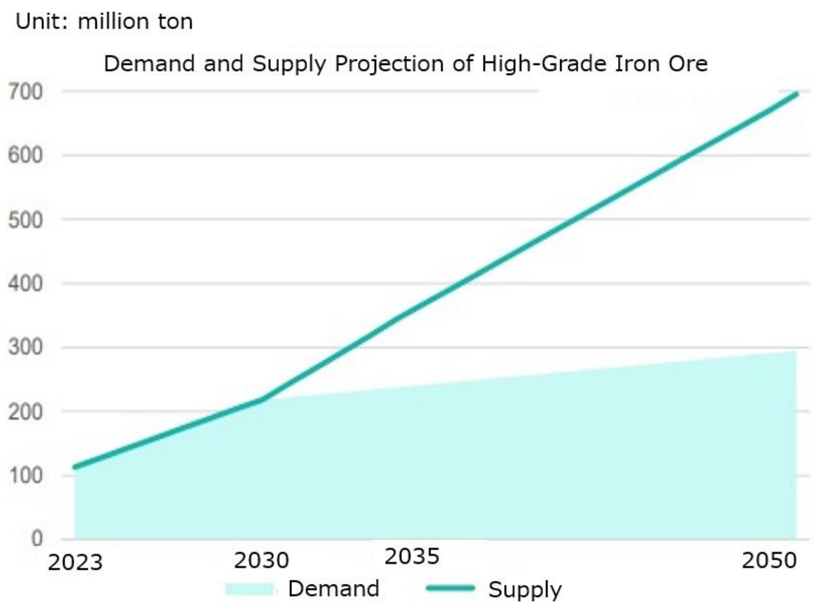
Since the function of a direct reduction furnace is reduction and not impurity removal, and since electric furnaces also experience significant Fe loss in slagging, iron ore for DRI must have as high a Fe content as possible and as low an impurity content as possible. Specifically, according to current technology, iron ore with “iron (Fe) 67% or more and silica (SiO_2) plus alumina (Al_2O_3) 2.2% or less” is considered optimal. However, deposits capable of producing this high-grade iron ore are limited to certain regions, such as Brazil and Canada.

Future supply and demand for iron ore

As decarbonization progresses, the share of steel products from electric furnace in global crude steel production is expected to rise in the future. However, the global demand for crude steel is expected to continue increasing, making iron ore reduction necessary. Iron ore reduction in direct reduction furnaces is considered to play an important role in the decarbonization of the steel industry.

However, as mentioned above, there are restrictions on iron ore grade and other factors in direct reduction furnaces. Some analysts believe that high-grade iron ore will become scarce after 2035 if the NZE (Net Zero Emission) scenario envisioned by the IEA is to be achieved.

Figure 21 High-grade iron ore supply and demand forecast



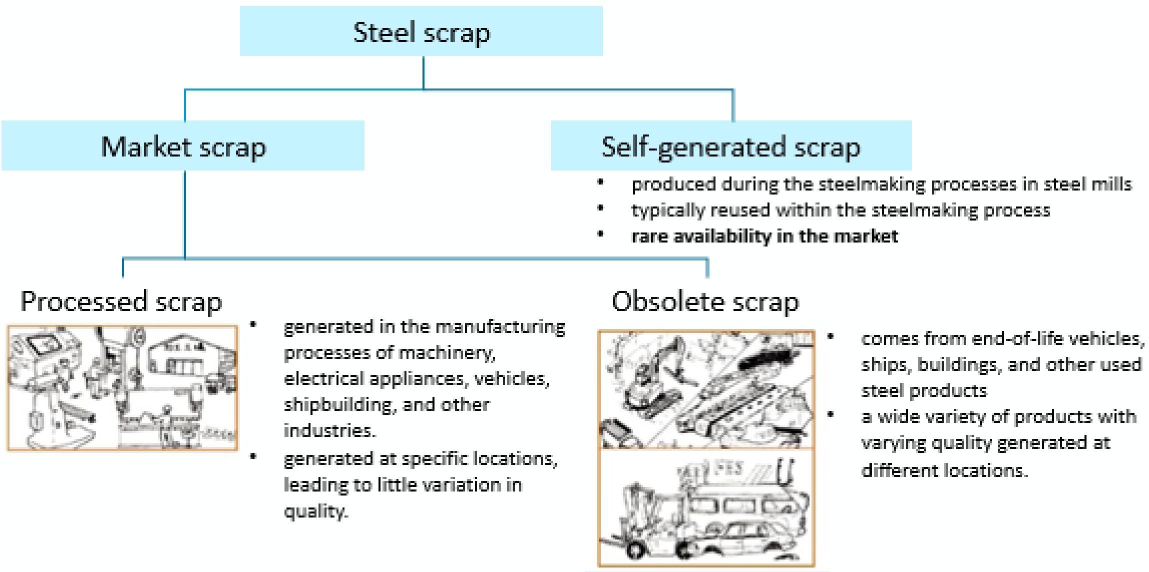
Source: Explanatory Material at the Second Meeting of Study Group on Green Steel for GX

Appendix 2 Steel scrap in Japan

Sources and types of steel scrap

The sources of steel scrap are broadly classified into self-generated scrap and market scrap, with market scrap further divided into processed scrap and obsolete scrap. Self-generated scrap is produced during the steelmaking processes in steel mills and is typically reused within the steelmaking process, resulting in its rare availability in the market. Processed scrap is generated in the manufacturing processes of machinery, electrical appliances, vehicles, shipbuilding, and other industries. It is generated at specific locations, leading to little variation in quality. In contrast, obsolete scrap comes from end-of-life vehicles, ships, buildings, and other used steel products, resulting in a wide variety of products with varying quality generated at different locations.

Figure 22 Sources and types of steel scrap



Source: Explanatory material for the 3rd Green Iron Study Group for GX Promotion, Japan Iron Recycling Industry Association

Processing and distribution of steel scrap

Next, regarding the processing and distribution of steel scrap, there are various methods of scrap collection. Specialized collectors gather the scrap, while dismantlers of buildings, automobiles, and other structures deliver the scrap to processing sites after removing a certain amount of nonferrous materials. Scrap metal is typically cut, crushed, pressed, or otherwise processed by scrap processors.

Figure 23 How to process steel scrap

Source: Explanatory material of Japan Iron Recycling Industry Association at the 3rd meeting of the Study Group on Green Steel for GX,

Types of Scrap Iron

Steel scrap classification is based on processing method, thickness, dimensions, and weight.

Heavy: Sized using guillotine shears, gas fusion, heavy machinery, and other methods.

Press: Rectangular cuboid-shaped products primarily made from processed steel sheet products, compressed and formed by a press machine.

Shredder: Mainly processed steel plate products as base material, shredded by a shredder machine and then sorted by magnetic sorter.

Shindachi: Chips and punching scraps generated during the manufacture of processed steel sheet products.

Steel dust: Cutting chips and swarf generated in the manufacture of screws, machine parts, and other items.

About High-Grade Scrap

To reduce CO_2 emissions in the steel manufacturing process, the introduction of innovative electric furnaces and an increase in steel scrap input in blast furnaces and converters are being planned and implemented. Scrap that can be utilized in the production of high-performance steel products, such as electromagnetic steel sheets automotive steel sheets, is commonly referred to as “high-grade scrap.”

This type of scrap contains fewer impurities compared to other types of scrap, particularly tramp elements like copper (Cu) and tin (Sn). Since a practical method for evaluating the amount of impurities in traded steel scrap has not yet been established, the grade of steel scrap is usually determined by its shape and origin. Therefore, high-grade scrap must have a clear origin. Steel scrap generated from manufacturing plants and structural steel scrap from demolition sites meet the requirements for high-grade scrap. In Japan, so-called “HS” and “Shindachi” are considered high-grade scrap, and “Shredder scrap" is also sometimes considered as high-grade scrap.

Supply and Demand for Steel Scrap

The supply and consumption of steel scrap in FY2023 are shown in Figure 26. The supply of steel scrap is calculated based on data from steelmakers’ consumption. Approximately 12 million tons of self-generated scrap are not marketed. While about 32 million tons of steel scrap are marketed, approximately 20% (or 6.8 million tons) are exported.

Figure 24 Feeding steel scrap

Supply total approx.44MT

Unit:1,000 t

Supply	Scrap generated in own factory 12,165			Scrap purchased domestically 25,454 (78.8%)		Export 6,851 (21.1%)	
	Converter plant 7,480	EAF plant 2,526	Casting plant 2,160	Processed scrap 7,142 (28.9%)	Wasted scrap 17,807 (71.1%)	Wasted scrap 5,481	Etc. 1,370

Scrap source →	Auto-mobile	Machine	Con-tainer	Building	Civil eng.	Etc.
	(9.6%)	(31.4%)	(2.9%)	(23.8%)	(20.3%)	(12.0%)

Domestic consumption total

Consumption	Basic Oxygen Furnace/converter	Electric Arc Furnace	Cast Iron	Others
	8,778	23,290	4,572	526

Source: Estimates based on "Annual Report of Iron Sources" by Japan Iron Sources Association, surveys by Ministry of Economy, Trade and Industry, Japan Iron and Steel Federation, Ministry of Finance, Japan Iron Sources Association, etc.

For reference, Table 7 presents the consumption of steel scrap from 2014 to 2023.

Table 7 Steel Scrap Consumption in Japan

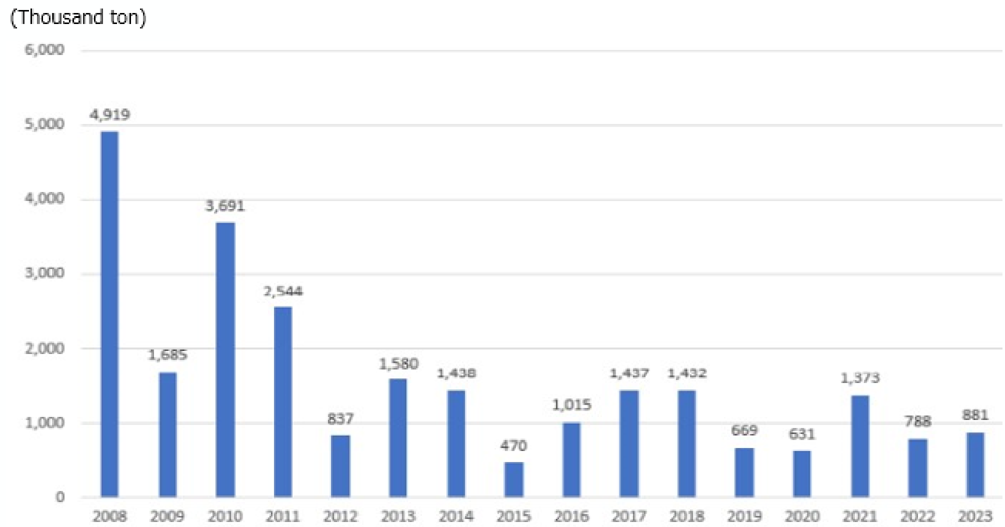
Unit: thousand ton

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Ratio 2023
Basic Oxygen Furnace/converter	10,365	8,622	9,694	10,381	10,333	9,244	7,762	9,999	8,656	8,731	23.6%
Electric Arc Furnace	26,505	24,904	23,872	25,397	26,180	24,438	21,417	24,748	24,112	23,096	62.4%
Cast Iron	5,139	4,924	4,844	5,163	5,233	4,988	4,126	4,704	4,609	4,670	12.6%
Others	787	757	796	834	955	773	579	521	580	521	1.4%
Total	42,797	39,207	39,206	41,776	42,702	39,443	33,883	39,971	37,957	37,018	100.0%

Source: Ministry of Economy, Trade and Industry, Japan Iron Source Association

As for the future volume of commercial scrap purchased by blast furnace mills, there is a possibility that these mills will increase their use of scrap. Additionally, they may purchase more commercial scrap in the future to mitigate CO_2 emissions in the steelmaking process. However, there has been no significant change in their purchases in 2023.

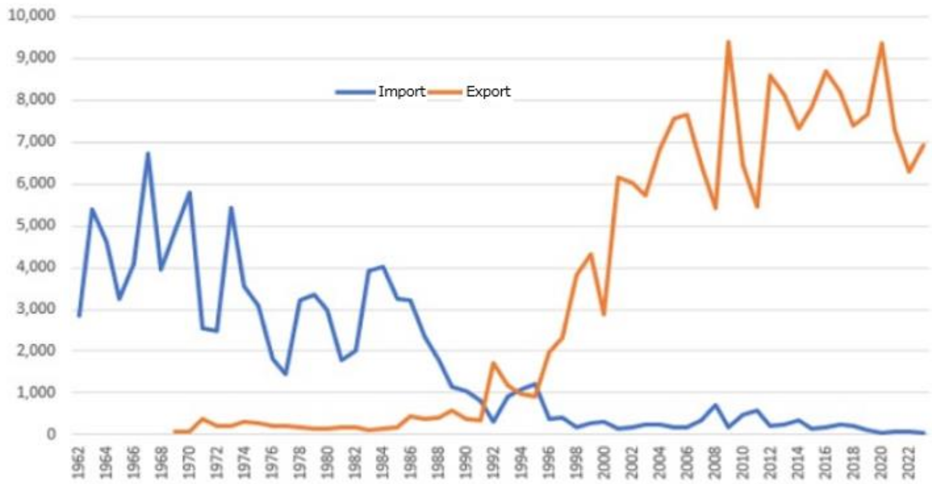
Figure 25 Blast Furnace Producers' Commercial Scrap Purchases (2008-2023)



Source: Nikkan Shijo Tsushinsha (estimated values)

Regarding exports and imports of steel scrap, Japan has been a net exporter since around 1992. In recent years, 7 to 8 million tons have been exported. While China was the primary export destinations around 2000, the destinations have become more diversified, with South Korea and Vietnam now accounting for 60% of the exports.

Figure 26 Exports and imports of steel scrap



Source: Trade Statistics, Ministry of Finance

Appendix 3 CFP (What is Carbon Footprint?)

Introduction

To achieve carbon neutrality, it is essential to promote emission reductions not only through the efforts of individual companies but also throughout the supply chain. To reduce emissions across the supply chain, it is necessary to establish a market where decarbonized and low-carbon products (green products) are purchased. A system to visualize the carbon footprint (GHG emissions per product) is indispensable as a foundation for creating such a market.

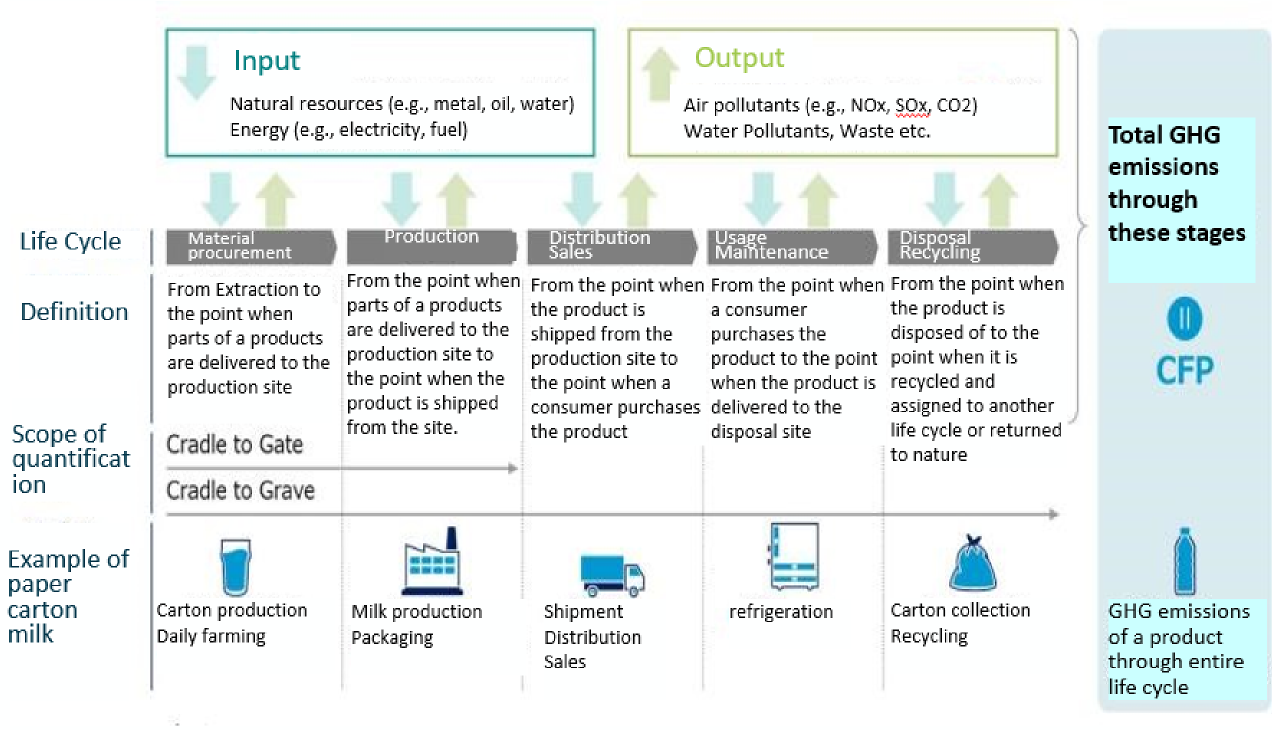
The environment surrounding companies is undergoing major changes, with various stakeholders—including customers, consumers, financial markets, and governments—calling for visualization of GHG emissions throughout the supply chain. This demand is becoming an important evaluation indicator that influences corporate value.

In addition, some companies in Europe and other countries are strategically monitoring their CFP and reducing emissions. It is essential for Japanese industry to actively engage with CFP to maintain and enhance its competitiveness.

Definition and Contents of CFP

CFP is defined as "sum of GHG emissions and GHG removals in a product system, expressed as CO_2 equivalents and based on a life cycle assessment using the single impact category of climate change" (ISO 14067: 2018). In other words, CFP is an indicator that represents the total amount of GHG emissions minus removals/absorptions at each stage of the product life cycle, from raw material procurement, production, distribution/sales, transportation, and disposal/recycling.

Figure 27 What is CFP?



Source: "Carbon Footprint Report" (March 2023) , Study Group on Calculation and Verification of Carbon Footprint Toward Carbon Neutrality in the Entire Supply Chain

ISO 14067:2018, as mentioned above, is an international standard that defines the basic quantification rules for CFP. The standard provides rules on how emissions are allocated to products, stating that allocation should be avoided whenever possible. When allocation is necessary, it shall be based on physical relationships as much as possible; if this is not feasible, it may be on the economic value of the co-products, for example.

Quantification of CFP and Scope 1,2, and 3

CFP and GHG Protocol Scope 1, 2, and 3 differ in terms of whether emissions are calculated per product or per organization. Additionally, there are various differences between CFP and GHG Protocol Scope 1, 2, and 3, including the scope of coverage, the treatment of emissions, and the rules referenced.

On the other hand, CFP can be used to quantify emissions from purchased products and services in the upstream portion of the entire supply chain (Category 1) in the GHG Protocol Scope 3 assessment. Additionally, CFP can be utilized to quantify downstream emissions from the use of sold products (Category 11). The following is a list of the relationships that can be utilized.

Figure 28 CFP vs. Scope 1,2,and 3

	CFP	GHG Protocol Scope1,2,3
Granularity of quantification	GHG emission on a product basis	GHG emission on a company-by-company basis
Scope of quantification	Entire life cycle or entire production process of a product	Entire supply chain (Scope 1 + Scope 2 + Scope 3)
Methodology of quantification	Assessment for stages of material procurement, production, distribution, sales, usage, maintenance, disposal, and recycling: • Cradle to Gate: quantify up to production • Cradle to Grave: quantify up to disposal and recycling Disassemble the process of each stage, quantify the GHG emissions in each process, and then sum up the emissions	• Scope 1: direct GHG emission by a business (fuel combustion, industrial process) • Scope 2: indirect GHG emission of electricity, heat, vapor supplied by other businesses • Scope 3: indirect GHG emissions other than Scope 1 and Scope 2 (emissions by other businesses related to the activities of the business) classified into 15 categories, and a methodology is established for each category
Major international standards	• ISO 14067 • Product Life Cycle Accounting and Reporting Standard	• Corporate Accounting and Reporting Standard (Corporate Standard) • Corporate Value Chain (Scope3) Accounting and Reporting Standard

Source: Study Group on Carbon Footprint Calculation and Verification, etc., Toward Carbon Neutrality in the Entire Supply Chain, "Carbon Footprint Report" (March 2023)

Appendix 4 Proposal by the Japan Iron and Steel Federation

Introduction

According to “Guidelines on Green Steel” formulated by Japan Iron and Steel Federation (JISF), a company which purchased steel products with certificates representing the amount of Achieved Amount of Reduction (AAR) in CO_2 emission can reflect the certificate in their Scope 3 emissions.

Before the 4th Meeting of the Study Group (December 17, 2024), the JISF explained to the secretariat of the study group about the status of their internal discussion regarding the concept of further reviewing the “Guidelines on Green Steel.” The concept of further reviewing aims to stimulate demand for Green Steel for GX by reflecting the value of products with AAR in reduced CFP. The following contents were explained by the secretariat of the study group at the 4th meeting as the proposal by the JISF.

GHG emissions allocation method

The proposal by the JISF is to use a method consistent with the “Allocation” specified in ISO 14067:2018 (international standard for CFP) and ISO 14044:2006 (international standard for LCA).

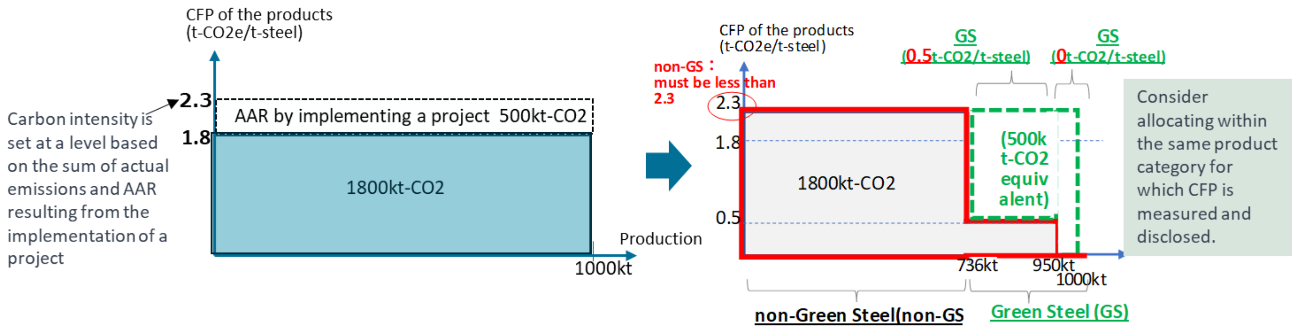
The concept is to set the carbon intensity of steel products flexibly at a level that ensures the total amount of GHG emissions (emission intensity × production volume) remains unchanged. This aims to meet the needs of customers who are willing to pay a premium for Green Steel for GX.

When setting this carbon intensity, the carbon intensity for any steel products shall be set to ensure that it does not exceed the actual carbon intensity plus the AAR achieved through GHG emission mitigation actions[26] . Since the emission intensity for each steel material is set so as not to change the total amount of greenhouse gas emissions (emission intensity× production), by setting such an

[26] Consideration shall also be given to allocating the CFP among the same products for which CFP is actually measured and disclosed. In this method, the total AAR allocated to the Green Steel to promote GX is equivalent to the difference in increased carbon intensity compared to the actual carbon intensity. The total difference of increased carbon intensity should be less than the total AAR.

emission intensity limit, the scope and range of reduction of emission intensity for steel materials as Green Steel for GX will be based on the AAR.

Figure 29 JISF's Proposed Greenhouse Gas Allocation Methodology



Allocate to the white area enclosed by the red line while ensuring that the total area of the blue remains unchanged.
The upper limit of the carbon intensity for steel products, other than green steel products, is set at the carbon intensity equivalent to the level before the implementation of mitigation activities, the Achieved Amount of Reductions (AAR) of which has been certified by a third party as having additionality.

Source: Japan Iron and Steel Federation

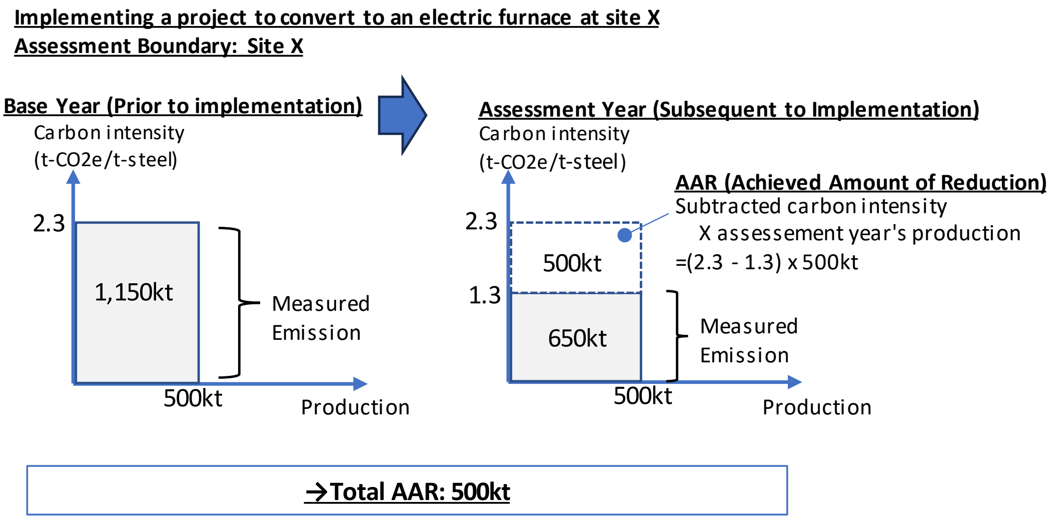
The emissions intensity in the base year, prior to the initiation of the emission mitigation action (project), shall be determined based on actually measured figures, specifically measured emissions divided by the production volume.[27]

The emission mitigation actions (projects) that is allowed for setting the emission intensity higher than the actual value, within the range of actual reductions, are limited to those implemented to mitigate GHG emissions in the production process. Additionally, the mitigated amount of emissions from these actions must be clearly identifiable, and the adequacy of this assessment must be verified by a third party.[28]

[27] AAR is equivalent to the amount obtained by multiplying the emission intensity in the base year by the production volume and then subtracting the actual emissions.

[28] An objective upper limit could be set to avoid unnecessarily preferential treatment of businesses that have not traditionally been involved in energy conservation efforts.

Figure 30 Japan Iron and Steel Federation's Proposed Method for Calculating Emission Reductions



Source: Japan Iron and Steel Federation

According to the JISF, the reason for this allocation is to meet the needs of steel customers who wish to support emission mitigation actions (projects) in steelmaking and to lower emissions associated with their use of steel products.

Steel production sites are dispersed, and considering the transportation distance between steel producers and customers, it is difficult for producers to implement emission mitigation actions (projects) according to a specific quantity of steel products to specific customers.

In ISO 14044 and other standards, allocation should be avoided whenever possible. When allocation is necessary, it should be based on physical relationships as much as possible; if that is not feasible, it may be based on the economic value of co-products, for example.

In the JISF proposal, GHG emissions are allocated on the basis that it is difficult for customers to specify the location of decarbonization projects in the production process and that a corresponding economic value (compensation) is paid for green steel to for GX.[29]

[29] In general products, economic value arises according to the level of functionality, but in the case of green iron for GX promotion, economic value is considered to arise in terms of lower GHG emissions.

List of Committee Members

(Member)

Keigo Akimoto	Leader and Chief Researcher, Systems Research Group, Research Institute of Innovative Technology for the Earth
Atsushi Inaba	President, Japan Life Cycle Assessment Facilitation Centre （LCAF)
Hiroki Kudo	Research Director, The Institute of Energy Economics, Japan (*Chairperson)
Yuko Hara	Director,Nippon Association of Consumer Specialists
Mari Yoshitaka	Fellow (Sustainability), Mitsubishi UFJ Research Consulting Co., Ltd.

(Observer)

Takanao Ibuki	Managing Director, The Japan Iron and Steel Federation
Hiroyuki Ueda	Chairman, Structural Design Department, Architectural Design Committee, Japan Federation of Construction Contractors
Shinichi Okimoto	Director, JFE Bars & Shapes Corporation
Eiji Orihashi	Managing Executive Officer, Head of Green Transformation Development, Nippon Steel Corporation
Takami Kato	Chair, Purchasing Subcommittee, Supply Chain Committee, Japan Automobile Manufacturers Association, Inc.
Hiroyasu Kobayashi	General Manager, Infrastructure Solutions Division, Iron & Steel Products Business Unit, Mitsui & Co., LTD.
Satoshi Tanaka	Director and Managing Executive Officer, Marubeni-Itochu Steel Inc.
Keisuke Tanabe	General Manager, Energy Department 3, Hanwa Co., Ltd.
Tetsuya Niwa	Executive Officer ESG Management Department, Daido Steel Co., Ltd.
Hiroyuki Tezuka	Fellow, JFE Steel Corporation
Susumu Nakamoto	General Manager, Green Transformation Strategy Office, Metal One Corporation
Atsushi Matsuo	General Manager, Steel GX Strategic Business Unit, Sumitomo Corporation
Shinji Miyaoka	Director and Executive Officer, Kobe Steel, Ltd.
Hiroshi Yanagisawa	COO, Metal + (Plus) Division, Metal Solutions SBU, Toyota Tsusho Corporation

Yu Yamamoto	Vice-Chairman, Environment Committee, The Real Estate Companies Association of Japan

(Other ministries)

Yohei Kawada	Director, Office for Resource Circulation Business Promotion, General Affairs Division, Environmental Regeneration and Material Cycles Bureau, Ministry of the Environment, Japan
Ryo Maeta	Counsellor, Counsellor’s office for Building Regulations,Housing Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan

(Secretariat)

Manufacturing Industries Bureau and GX Group, Ministry of Economy, Trade and Industry

Meeting details

1st Meeting (October 17, 2024)

Establishment of the study group

Situation surrounding the steel industry

Hearings with international organizations (International Energy Agency)

2nd Meeting (November 7, 2024)

Explanation from the secretariat regarding CO2 generation in the manufacturing process, actual amount of reduction, etc.

Hearings with relevant parties (Nippon Steel Corporation, JFE Steel Corporation, Daido Steel Corporation, Sumitomo Corporation)

3rd Meeting (November 25, 2024)

Explanation from the secretariat (review of previous discussions, certification and labeling of green iron, increasing demand for green iron to promote GX, etc.)

Hearings with related parties (JFE Steel Corporation, Japan Iron Recyclers Association, Japan Automobile Manufacturers Association, Inc.)

4th Meeting (December 17, 2024)

Explanation from the secretariat (expansion of demand for green iron for GX promotion, certification and labeling of green iron)

Hearings with related parties (Real Estate Association of Japan, Japan Construction Industry Association)

5th Meeting (January 22, 2025)

Explanation from the secretariat (draft summary)